POWER PLANT ENGINEERING

Established Over 35 Years

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Twice Down But Not Out

HELLO ANYBODY. This is station PPE broadcasting the Slugger Redwood—Dame Nature life-and-death fight right from the arena in the California woods. It's simply gorgeous out here in the mountains. Slugger is getting on his mitts for the first time so old Dame has the best of him at the start and here goes the gong at exactly 2 min. 14 2/5 sec. past 12 o'clock sun time April 10, in the year of our Lord 306.

Slugger takes a blow from the east to the body but eases back and slaps Dame a pretty one right in the face. Dame clinches and gets in some rabbit punches. Slugger is dizzy, weaves around, now he is back with a right and left slap and the round is over.—Grapes must be good to eat.—Here comes another round, it's just like the last—Redwood for your homes, it lasts.—Here's the gong. Boy this is going to be good. Dame is mad. She has him by the arms, whirls him around but he's back in a flash. Oho! he's going down, the earth broke under him. An earthquake? No, not out here. Hear the giant crash? Well it was a good fight while it lasted, just 900 yr. Good-night everybody.

We're on the air again, station PPE broadcasting the two-to-one fight between Kidd B, age 700, and Scrapper C, age 500, sons of the famous Slugger Redwood on one side and California Joe, the Woodsman on the other. It's now 7:35½ o'clock, October 13, 1906.—California gold is good gold.—Say, you know I would a whole lot rather talk about this wonderful fall scenery out here than the harvesting of good old fighting trees with an ax, and—thank you, I won't have to for it is all over and Babe D has sprung up to defend the family name and furnish fodder for saw mills like that described on page 975.—Power plants make prosperous people.—PPE signing off. Toodle-oo.

A Policy For Power

Its Determination and Execution

By MARCUS K. BRYAN
Charles T. Main, Inc.

The use of economical planning is not applied as consistently or continuously to the industrial power plant as it is to manufacturing departments, for the reason, perhaps, that the procedure in establishing a power plant policy is only vaguely understood, if at all. This article explains how the Champion-International Company, manufacturers of high grade paper in Lawrence, Massachusetts, for more than fifty years, established and executed a profitable development program for its power plant.

IN 1928 WE WERE asked by the management of the Champion-International Paper Co. to confer with them regarding the possibilities of remodeling the steam and power generating system at their mill, for the purpose of reducing costs and to provide for increased steam and power requirements necessitated by changes contemplated for the paper mill.

Briefly, the contemplated mill changes were:—

(1) Abandon two steam driven paper machines and replace these with one electrically driven paper machine to produce considerably more paper than the abandoned machines.

(2) Increase the coating mill to handle the larger paper production.

(3) Change the calenders from being group driven by a steam engine to individual electric motor drive.

It was planned to make these changes in the order listed and to complete this program, business warranting, in about 3 yr. (At present, 3½ yr. later, all the changes have been completed in the order originally proposed by the management.)

After briefly considering the proposed mill changes, it was obvious that the steam and power demands would increase as the changes progressed and at an early stage in the program these demands would exceed the capacity of the power plant equipment. It was also manifest when considering the proposed mill changes and the cost of them, that the necessary power plant changes would probably be most advisably accomplished with a development program closely following the mill change schedule and ultimately resulting in a power plant of required capacity and good economy.

Such a program was set up in 1928 and it was completed in three steps, the last step being completed in July of 1931.

An accounting of the procedure used in formulating this program, and of the manner of executing it, is of interest and perhaps of value to show what can be accomplished with careful planning and anticipation. The following is an account of how the program was determined and of its development, with brief reference to the expected and realized results.

A policy for power plant development could not be intelligently formulated without carefully studying the property, the existing equipment, the present and the probable future loads. Examination of those elements in this case disclosed several feasible plans for meeting the increasing mill demands. Apparently all plans were not equally economical and, accordingly, analyses of the attractive schemes were needed to reveal their comparative economic worth and their practical limitations.

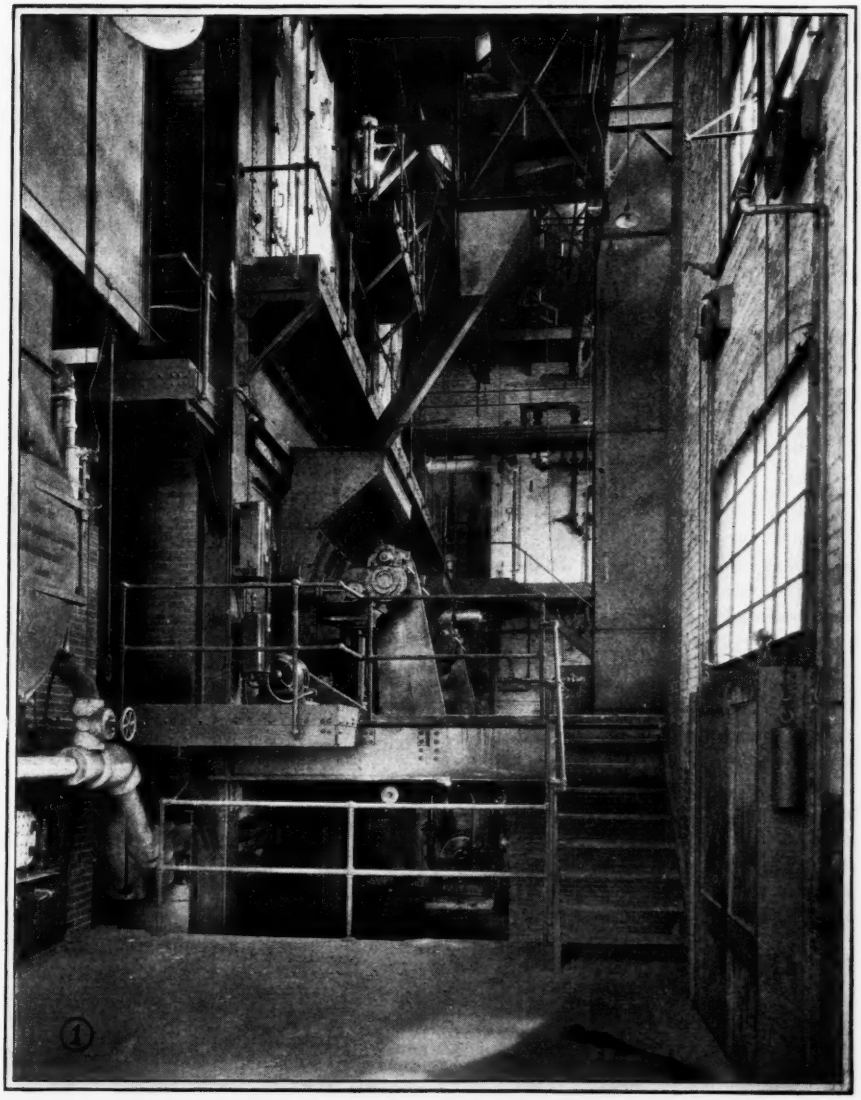
General Description of Plant in 1928

Steam was generated in six return tubular, hand stoker fired, boilers, served by a red brick chimney 8 ft. in diameter at the top by 175 ft. above the grates. Four of these boilers operated at 110 lb. pressure and two at 150 lb. pressure. Boilers were set in continuous battery and suspended about 6 ft. above the fire.

Coal was unloaded by hand into ground storage from side dump cars on a 15-ft. high trestle paralleling the boiler house and about 45 ft. from it. From storage the coal was wheeled in barrows and dumped on the boiler room floor in front of the boilers.

Ashes were shoveled into barrows in a small tunnel under the boiler room floor and wheeled to an elevator at one end of the boiler room, elevated and piled on the

r Plant Development



Four of the old 110-lb. H. R. T. Boilers were removed to make room for these two 400-lb. water-tube boilers.

ground outside. Local contractors took ashes from this pile and away from the property without charge.

Feedwater was pumped by a duplex plunger steam pump from an open type metering heater through an economizer into the boilers. The gases from soda ash burning passed through this economizer, raising the feedwater temperature some 50 degrees.

The boiler plant carried the steam load comfortably and the monthly efficiency averaged about 67 per cent.

Power to drive the mill was supplied by a Filer & Stowell noncondensing, twin engine, belted to a line shaft driving the calenders and two small electric generators and by a hydroelectric installation consisting of two modern vertical water wheel generators and by a simple noncondensing engine belted to the paper machines which were to be removed after the new machine was installed.

As a standby unit to the water power plant, there was a 1250-kv-a. condensing General Electric turbine generator of old design. This machine was not run excepting in emergencies and at times when the hydro output was reduced by high or low water. The need for this machine varied from 20 to 80 days a year.

Equipment, in general, excepting the hydroelectric installation made in 1926, would average about 20 yr. old. It had been well maintained.

The mill operated 24 hr. a day and approximately 7300 hr. a yr.

Steam Distribution and Power Load in 1928

Steam distribution from the boiler plant for summer and winter conditions summarized about as follows:

Boiler Steam Distribution	Steam used Lbs. per Hour Summer	Winter
Filer & Stowell Engine	13,300	19,300
Paper Machine Engine	4,000	4,000
Auxiliaries (Pumps & Compressor)	2,200	2,800
Paper Machine Dryers (hp. Steam)	9,000	9,000

Heating process Water	1,500	2,000
Sulphite Plant	7,500	9,000
Soda Plant	8,000	8,500
Building Heating		7,300
Size Tank		700
Total Steam Load	45,500	62,600

Uses of steam for process work and space heating for summer and winter conditions summarized about as follows:

Process Steam Use	Pressure Required	Steam Used Lbs. per Hr. Summer	Winter
Coated Paper Mill	5	11,300	14,700
Heating Process Water	5	1,500	2,000
Paper Machine Dryers*	5	8,000	8,000
Building Heating	5	.....	500
Building Heating	110	.....	6,800
Sulphite Mill	110	7,500	9,000
Soda Mill	110	8,000	8,500
Size Tank	110	.....	700
Total Process Steam Load		36,300	50,200

*Note: This item does not include drying steam for old machines which were to be abandoned.

The average power load exclusive the paper machines to be abandoned was supplied about as follows:

Hydroelectric Power	950 Kw.
Filer & Stowell Engine	
(1) Calenders	450 Kw.
(2) Generators	230 Kw.
*Total Average Load (Equivalent Kw. at switchboard)	1630 Kw.

*Note that this does not include No. 2 Engine.

Normal variations in this load were moderate and caused peaks of only 1900 to 2000 kw.

To understand the power supply system better, it should be noted that the hydroelectric power output was subject to large seasonal variations, falling to 400 kw. at times of high and low water. Also, for about six months each year, the output for the day period, 6 a. m. to 6 p. m., was less than that for the night period, 6 p. m. to 6 a. m., as illustrated by the graph (Fig. 4) showing estimated output for a year of average water flow. Water for hydro power was purchased from the Essex Co. This company controls the use of water on the Merrimac River at Lawrence, Massachusetts, and furnishes water to numerous mills through a system of canals.

Plant Operation

The majority of these plants operate 8 hr. a day, consequently the demands for water are greatest during the period from 6 a. m. to 6 p. m. The charges for water were such that hydro power cost about 8.3 mills on the paper company's switchboard.

Analysis of the plant heat balance did not show any wastes worth recovering. The noncondensing power units were piped to processes using steam, and returns were well collected and either brought back to the feedwater heater or were used in manufacturing processes requiring warm water. L. B. Rogers, Chief Engineer of the plant, was producing excellent results with the equipment although the operating expense did not compare favorably with modern industrial power plant practice. It was believed that this expense, amounting annually to somewhat less than $230,000, of which labor was about 23 per cent, could be sufficiently reduced with a modernly equipped plant to justify the necessary investment.

Power and steam requirements with the mill changes completed had to be estimated, and the data collected to study the existing conditions were valuable as a basis from which to make these estimates. It was expected

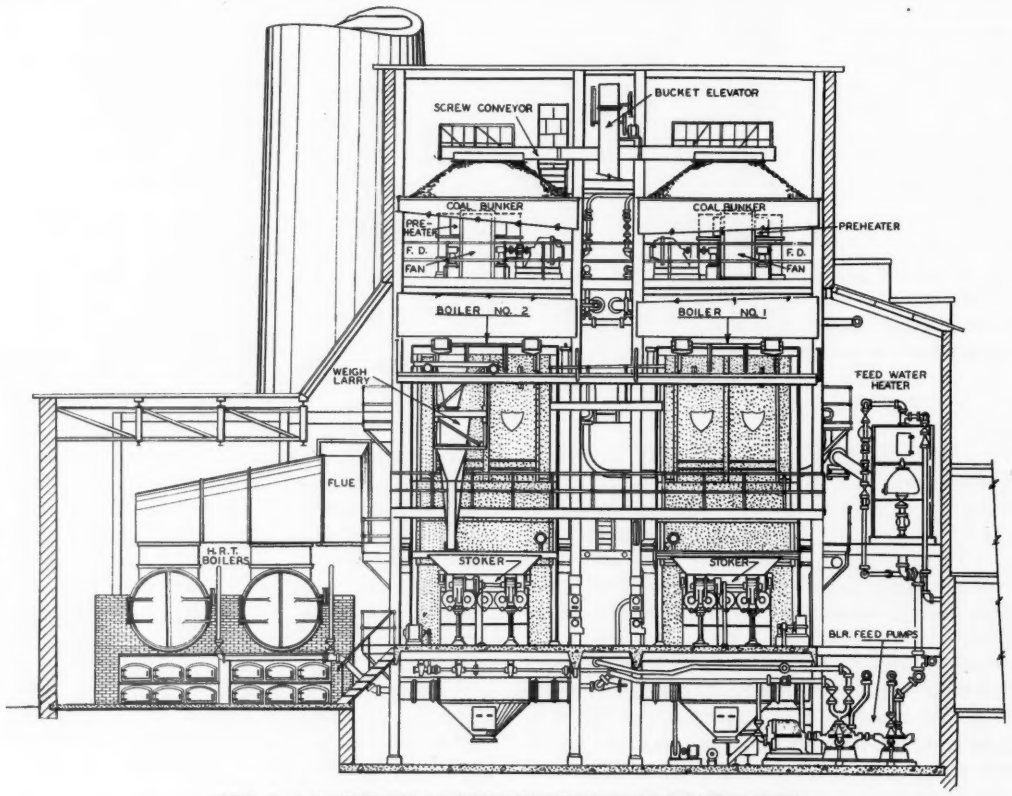


FIG. 2. LONGITUDINAL SECTION THROUGH BOILER HOUSE

that future requirements would approximate the following:

1928 Power Load	1630 kw.
Increase for New Paper Machine	500 kw.
Future *Average* Load at Switchboard	2130 kw.
Future Peak Load	2400-2500 kw.

Process Steam Uses	Lbs. Pressure Required	1,000,000 B.t.u. used. Per Hour Average Summer	Winter
Coated Paper Mill	5	15.80	22.20
Heating Process Water	5	3.75	5.00
Paper Machine Drying	5	19.72	19.72
Total of Uses at 5 lb. pressure		39.27	46.92
Sulphite Mill	110	8.33	10.68
Soda Mill	110	7.66	7.96
Building Heating and Size Tank	110	.....	8.25
Total of Uses at 110 lb. pressure		15.99	26.89

Variations, from the average, in the use of 5-lb. steam were about 10 per cent in both summer and winter. In winter the variations, from the average, in the use of 110-lb. steam were about 20 per cent and in the summer these were about 15 per cent.

The heat uses summarized above do not include any feedwater heating and are intended to be only the heat actually used in the process, or the difference between the heat in steam entering and the heat in steam or condensate leaving the process. These data were essential to develop the picture properly and to determine the scheme of alterations and expansion which would be most economical.

A few simple figures show a considerable block of power available from noncondensing prime movers using steam at 150 lb. pressure, the pressure allowable on two of the six existing boilers. Further consideration quickly shows that nearly all of the power could be made by a noncondensing and bleeding turbine operating with a boiler pressure of about 400 lb. The limits within which boiler pressure would be chosen appear, therefore, to be 150 to 400 lb. With the lower pressure, two of the present boilers could be used and maximum use made of the hydroelectric plant and possibly of the Filer & Stowell engine and the existing steam turbine.

If the higher pressure were used, new high-pressure boilers would be required, the Filer & Stowell engine would be abandoned and the output of the hydroelectric plant would be a minimum.

Obviously, the maximum use should be made of existing equipment and its abandonment can be justified only upon the basis of reduced operating charges producing worth while earnings on the cost of new equipment.

Plans for Final Consideration

After studying various possible arrangements, three plans for meeting the ultimate requirements remained for final deliberation. These were:

Scheme 1

Remodel the boiler plant by installing four new 90-in. 150-lb. return tubular boilers, retaining the two present 150-lb. boilers. The setting height of all boilers would be about 9 ft. and single retort underfeed stokers would be installed under all boilers. Superheaters would be installed on all boilers. The coal and ash handling systems would not be changed. The boiler house would not be materially changed.

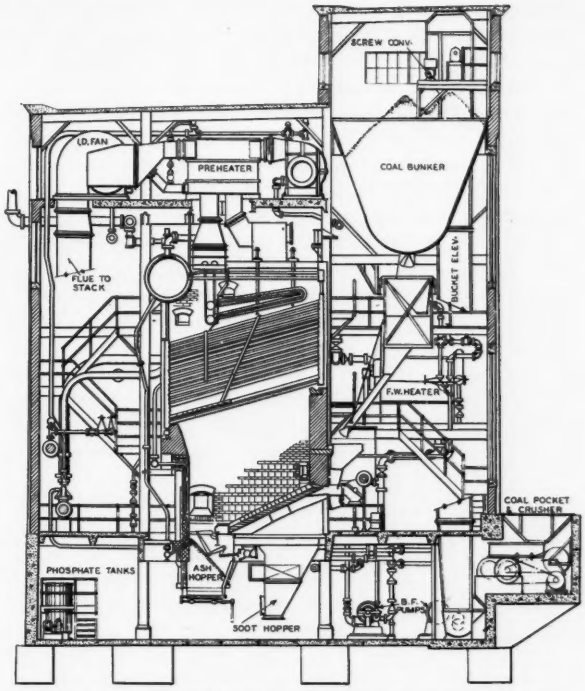


FIG. 3. CROSS SECTION THROUGH BOILER HOUSE

Power would be made:

(a) with the Filer & Stowell engine fitted with a 600-kw. belted generator
(b) with a 600-kw. Uniflow noncondensing engine generator set installed near No. 2 engine and
(c) with the hydro-plant.

The engines would exhaust to paper machine dryers and to the coating mill.

The General Electric turbine generator would remain in its present location and be fitted with a bleeder gear and piped to exhaust into the low-pressure piping system. With the small capacity in the other steam machines, this turbine would be primarily a stand-by against low water. It would have to be operated at some time during the day about 200 days each year. This plan made the maximum use of existing equipment and cost less than any plan proposed.

Scheme 2

Remodel the boiler plant as in Scheme 1 and install a 600-kw. generator belted to the Filer & Stowell engine and a 1500-kw. bleeder condensing steam turbine generator, near present No. 2 engine, with bleeder connection piped to paper machine dryers and coating mill. The engine and turbine, with the hydro plant, would furnish power for most of the time. The General Electric turbine generator in its present location would be fitted with a bleeder gear and connected to the low-pressure piping system. It would be a stand-by machine and would be required to run but little.

Scheme 3

Remodel the boiler plant by installing two 400-lb. pressure water-tube boilers fired with multi-retort stokers and equipped with superheaters and air preheaters. These boilers would be placed in the space now taken by the four 110-lb. h.r.t. boilers. The two 150-lb. boilers would be maintained as at present. Coal and ash han-

dling equipment would be installed to reduce labor costs to the practical minimum. The present building would be remodeled to accommodate the new equipment.

Power would be generated by a 2500-kw. extraction and noncondensing steam turbine generator to be installed at the site of present No. 2 engine, and piped for extraction at 110 lb. pressure to the processes using steam above 10 lb. pressure and to exhaust at 10 lb. pressure to the coating mill and the paper machines. The Filer & Stowell engine would be abandoned. The General Electric turbine generator would be relocated alongside of the 2500-kw. machine and fitted with a bleeder gear for extraction at 10 lb. pressure into the low-pressure piping system.

Practically all power would be supplied from the 2500-kw. machine, and such as was not so supplied would be made by the hydro plant. The General Electric turbine generator would be a stand-by machine.

Initial Installation for Above Schemes

The electric power required in the immediate future, before motor driving the calenders, would not exceed the capacity of existing equipment, consequently changes in the power system were not immediately necessary.

Depending upon the scheme selected for the full development, the initial steps could be made as follows:

Scheme 1-A and 2-A

Remodel the boiler plant with new return tubular boilers, stokers and superheaters as in Scheme 1, and install bleeder gear on present turbine and connect it with low-pressure piping to the paper machines. The Filer & Stowell is retained as at present and the hydro plant is run as at present.

Scheme 1-B

This is the same as scheme 1-A, excepting that a 600-kw. uniflow engine is installed near No. 2 engine and piped to the paper machines. The Filer & Stowell engine and the General Electric turbine remaining without change. The hydro plant continues without change.

Scheme 3-A

Remodel the boiler plant as for Scheme 3, all new equipment to be built for the ultimate pressure of 400 lb., but operated at 150 lb. pressure with low superheat until the 2500-kw. turbine installation is made.

Move the General Electric turbine generator to its new location, fit it with a bleeder gear and pipe to paper machines. The Filer & Stowell engine would be left without change and it, with the hydro and the General Electric turbine generator, would supply power.

Effect of Mill Changes on Capacity

In appraising the various schemes, an important consideration was the effect of mill changes upon the capacity of the equipment proposed for each scheme, continuity of operation being a cardinal requirement.

Estimates of average steam loads, summer and winter, for the present plant and for the enlarged plant with each scheme of operation, were the following:

Item		Lb. Steam per Hour Summer	Winter
Present Plant		45,500	62,600
Scheme 1-A	150 lb. pressure	59,500	77,000
Scheme 1-B	150 lb. pressure	56,600	74,000
Scheme 3-A	150 lb. pressure	59,500	77,000
Scheme 1	400 lb. pressure	60,000	78,000
Scheme 2	400 lb. pressure	64,000	79,000
Scheme 3	400 lb. pressure	50,000	66,000

Power loads, averages and peaks, at present, and in the future, were estimated to be the following:

	Kilowatts Average	Peak
Present Plant	1630	1900
Present Plant, with No. 6 machine	2130	2400
Present Plant, with No. 6 machine and calenders motorized	2290	2600

The capacity in steam power which must be available to supply the deficit in water power when river is high, allowing 400 kw. for hydro at such times, would be—

	Average	Peak
Present Plant	1430	1500
Present Plant, with No. 6 Machine	1730	2000
Present Plant, with No. 6 Machine and calenders motorized	1890	2200

Examination of these loads brought out the following points:

(1) Steam loads with the new paper machine installed, Schemes 1-A, 1-B and 3-A, would be such that four of the present boilers would not be enough to carry the load without taking a considerable risk of interrupting mill operations, accordingly it would be better

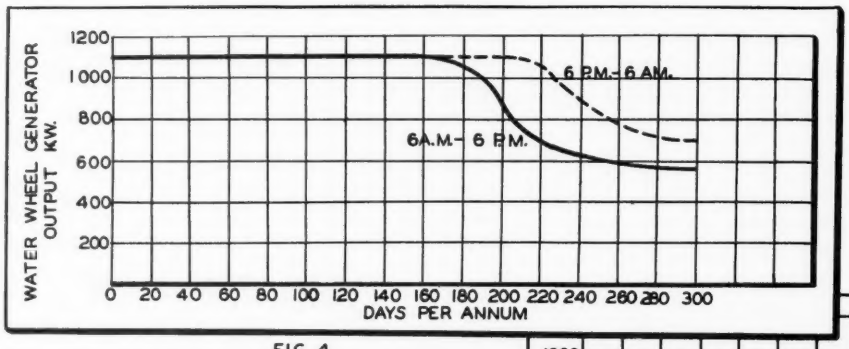


FIG. 4

FIG. 4. HYDROELECTRIC POWER OUTPUT DURATION CURVE, AVERAGE YEAR.

FIG. 5. AVERAGE POWER DEFICIT TO BE MADE UP WITH HYDROELECTRIC POWER.

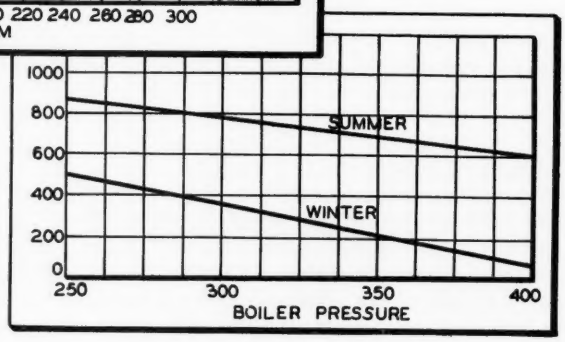


FIG. 5

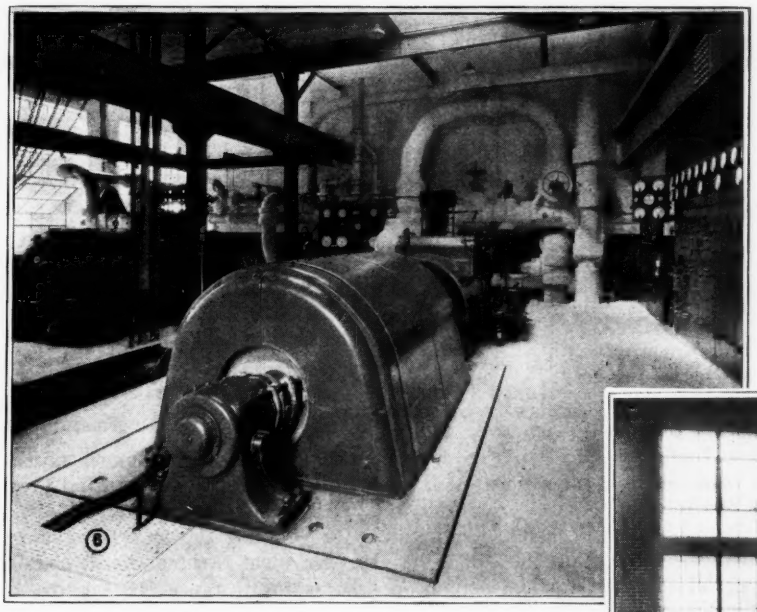
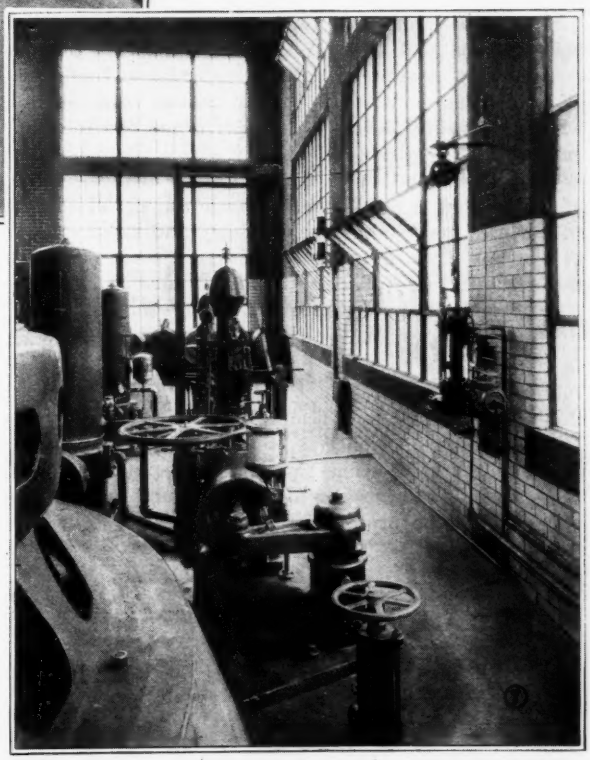


FIG. 6. Interior of the turbine Room with the 1250-Kv-a. Machine at the Left, the New 2500-Kw. Unit in the Foreground. New High-Pressure Piping Is Shown Along Wall

FIG. 7. Interior of Hydroelectric Generator Room Showing the Regulator Which Controls the Water Wheel Gate Opening from the Pressure in the Low-Pressure System, Mounted on the Wall at the Right. The Gate Opening Recorder Is Shown in the Center Foreground on the Gate Opening Mechanism



to make any needed changes in the boiler plant before rather than after the load increased.

(2) All installed boiler capacity would be needed at times of low water to operate the plant with Scheme 1 or Scheme 2, whereas with Scheme 3 there would be spare boiler capacity at all times.

(3) The new paper machine addition might load the existing power equipment at times of high and low water to the limit of its capacity. It was, however, thought improbable that much trouble would result on this score with either of Schemes 1-A and 3-A, and if trouble was experienced it would be only at times of high water which were of short duration, therefore these schemes could be safely considered as a step toward the ultimate development.

(4) Scheme 1 did not provide the comfortable surplus of power capacity furnished with Schemes 2 or 3. It was recognized that the normal operating capacity of Scheme 3 was concentrated in one large generating unit but the ability to schedule inspections for times of light load and ample water was considered practically to eliminate this objection.

The balance of practical considerations for operation and also for construction favored Scheme 3, the first step of which was Scheme 3-A.

Choice of Steam Pressure

The working steam pressure for Scheme 3, namely 400 lb., was decided from the results of studies showing the power available from process steam supplied through a noncondensing and extraction steam turbine with each of various turbine throttle pressures. These figures were worked out for the pressures of 250, 300, 350 and 400 lb. and varying superheats. The graph (Fig. 5) shows the average deficit in steam power which must be made up from hydroelectric power with each of the above pressures and a superheat of 150 deg. F.

Operating costs were easily set up for the different pressures showing their influence upon hydro power cost. The operating costs examined together with the investment necessary for each pressure condition indicated the fair evaluations of each pressure for the particular conditions.

The thought of making savings by the replacement of water power with steam power may be startling to some. It is, nevertheless, a fact that steam power made by noncondensing turbines or engines as a by-product of process heat requirements is generally lower in cost than hydro power and this case was no exception.

Reduction in the need for water power and the saving in cost of water as a result of higher steam pressure justified the additional investment to raise the pressure. The increased investment to go from 250 lb. pressure to 400 lb. pressure was estimated as about $20,000 and the savings so produced were estimated at $6000 per yr.

Financial Comparison

Complete and carefully prepared estimates, giving investments and operating costs for each plan, showed Scheme 3 to be the most attractive from the dollars and

(*Continued on page 983*)

DRAINING MOISTURE *from* TURBINES

Excessive Moisture Causes Lowered Turbine Efficiency and Blade Wear. Some Methods That Have Been Used to Eliminate Excessive Moistures from the Lower Stages

WHEN STEAM is expanded in a turbine, some of the heat is converted into work and both the pressure and temperature of the steam drop. With superheated steam and back pressure turbines, the turbine exhaust may be superheated but under usual conditions of condensing service the exhaust is wet regardless of whether the throttle supply is superheated or saturated. In practice, the quality of exhaust steam may be as low as 85 per cent, although a more or less arbitrary limit of 90 per cent is usually set on large units. This moisture causes lowered turbine efficiency and rapid erosion of the last rows of blades. Erosion further decreases the efficiency, increases the risk of failure and turbine outage and necessitates frequent blade renewal.

In the days of low pressures and saturated steam, it used to be said that one per cent reduction in quality increased the water rate two per cent; one per cent due to lower turbine efficiency and one per cent due to the moisture which was weighed but did no work. With superheated steam, this is no longer true, yet the increase in size of units, blade speed and steam pressures makes the problem of moisture removal increasingly important.

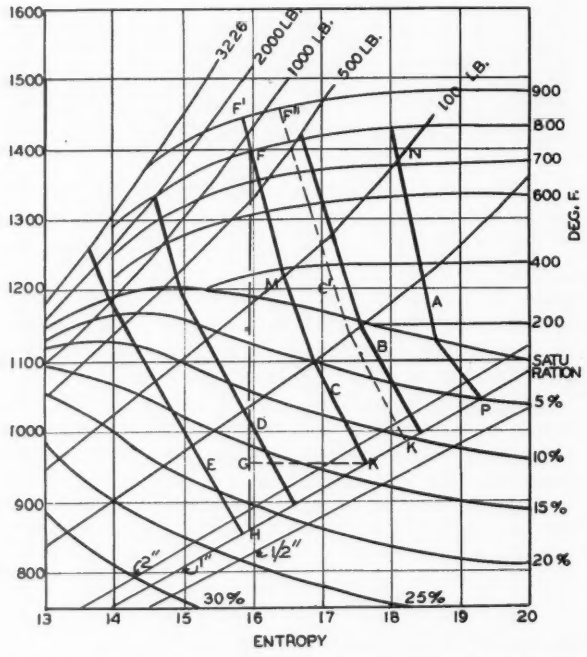


FIG. 1. APPROXIMATE EXPANSION CURVES OF TURBINES SHOWING INCREASE OF MOISTURE IN EXHAUST STEAM WITH PRESSURE. SCALE AT LEFT=TOTAL B.t.u. PER LB.

Ideal Turbine Exhaust Wetter Than Actual Turbine Exhaust

On Fig. 1 are shown a number of assumed expansion lines, A, B, C, D and E, for a range of initial pressures from 150 to 3200 lb. They are all drawn for a constant temperature of 800 deg. F. and an exhaust pressure of 1 in. Hg. An ideal turbine would have a vertical expansion line, as for instance FH on line C. Actually the line slopes to the right as shown, the greater the slope the lower the turbine efficiency. This efficiency is usually expressed as the Rankine (cycle) Ratio which mathematically is the ratio of the heat actually turned into work to the total heat available, that is for line C, FG÷FH.

From an inspection of the expansion lines, it is evident that efficiencies are higher in the superheat than in the saturated region so that the higher the proportion of expansion in the superheat region the higher the efficiency. The total heat drop of line A is about the same as line E but in the first case 66 per cent of the expansion line is in the superheat region and the Rankine Ratio is about 81.5 per cent. In the second case, conditions are reversed, only about 17 per cent of the expansion line is in the superheated region and the efficiency ratio drops to 77 per cent.

For a given total temperature, the higher the pressure and the more efficient the turbine the higher the moisture content of the exhaust. This is shown by the increasing wetness of the exhaust from 5 per cent for A to about 23 per cent for E. With ideal turbines the moisture content would be much higher; for line C it would be about 23 per cent as at H instead of about 14 per cent as at K. Raising the total temperature but maintaining the same pressure would shift the expansion line to the right as C to C' assuming 850 lb., 900 deg. F. as at F'' instead of 850 lb., 800 deg. F. as at F. A 400-lb. Westinghouse turbine with a blade efficiency of 82 per cent operating at 29 in. Hg. was reported to have a moisture content at exhaust of 10.8 per cent with an initial temperature of 750 deg. F. and but 8 per cent with 850 deg. F. initial temperature.

Small Turbines Less Efficient

High steam pressures are more suitable for large than for small turbines because at high pressure specific volumes are small and small turbine blades short, making the blade clearance and packing gland losses larger in proportion. A comparison of the actual effect of moisture on turbine efficiencies is therefore difficult because losses due to wetness and to clearance both

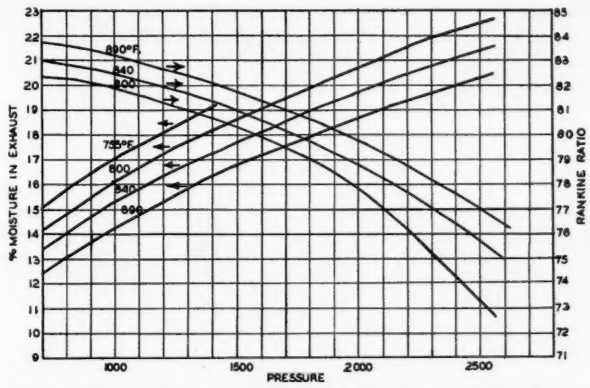


FIG. 2. MOISTURE IN THE EXIT STEAM AND TURBINE EFFICIENCY AS FUNCTIONS OF PRESSURE AND TEMPERATURE

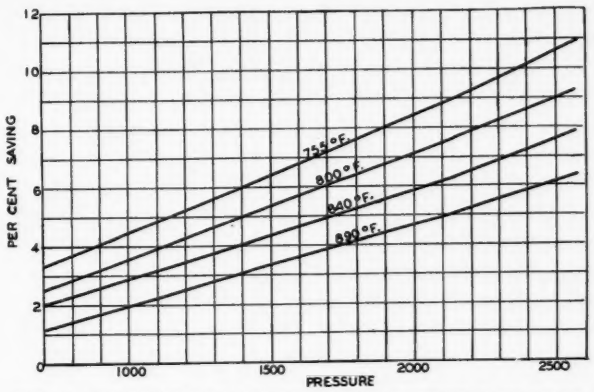


FIG. 3. INCREASE IN EFFICIENCIES POSSIBLE IF MOISTURE COULD BE HELD TO 1 PER CENT BETWEEN CYLINDERS

increase with pressure and it is difficult to separate them. This has been done, however, by Brown-Boveri in tests and calculations, the results of which are shown by Fig. 2. One ton of steam was assumed for every atmosphere of steam pressure so that apart from the braking effect of the moisture the turbine efficiency should remain constant. Curves running from the lower left-hand to the upper right-hand corner, show the moisture in the exhaust, those running from the upper left-hand to the lower right-hand corner show the Rankine Ratio expressed as a percentage.

Moisture Limit About 10 Per Cent

Increase of pressure from 700 to 2600 lb. causes an efficiency loss of practically 8 per cent, all of which is presumably due to moisture. Within the moisture range of 10 to 20 per cent, increasing the initial temperature 50 deg. F. causes an increase of efficiency of from 0.5 to 0.75 per cent.

Past American experience has placed a maximum limit of 10 per cent moisture and this limits the initial pressure to about 450 to 550 lb., the exact value depending upon the allowable temperature and turbine efficiency. For higher pressures, reheating has been the most satisfactory solution of the high moisture problem. For instance, steam would be expanded from F to M in a high pressure cylinder, then heated again at constant pressure along the line MN and again expanded along NP in the low pressure cylinder.[1]

Reheat

Reheating serves the double purpose of increasing the available heat drop and increasing the efficiency by decreasing the moisture. It does, however, introduce complications which could be eliminated if the moisture could be drained or separated out some other way. Figure 3 shows the savings which Brown Boveri calculates could be effected if moisture could be reduced to 1 per cent between turbine cylinders. The lower the initial temperature the greater the possible savings.

Unfortunately, this moisture is extremely difficult to remove and although all turbine companies appreciate its importance and have numerous patented devices such as drainage grooves, bypasses and orifices, the best results reported so far indicate a removal of only about 25 per cent[2] of the total moisture. Apparently this moisture is concentrated along the outer half of the blade but not wholly at the periphery which accounts for the ineffectiveness of the various devices.

[1]Reheat Practice, Control and Operation p. 697 July 1, 1931.

Other Moisture Removal Methods

In extraction turbines, some of this water is removed with the extracted steam and some is removed between stages in the low pressure end by special drain channels as shown in detail on a Brown Boveri turbine by Fig. 4 and on a Westinghouse turbine by Fig. 5. In both figures, the special drain channels are indicated by A and the extraction points of Fig. 5 by B. Moisture collected in these special grooves is carried off in different

[2]Steam Turbine Economics in Power Generation, p. 741. July 1, 1930.

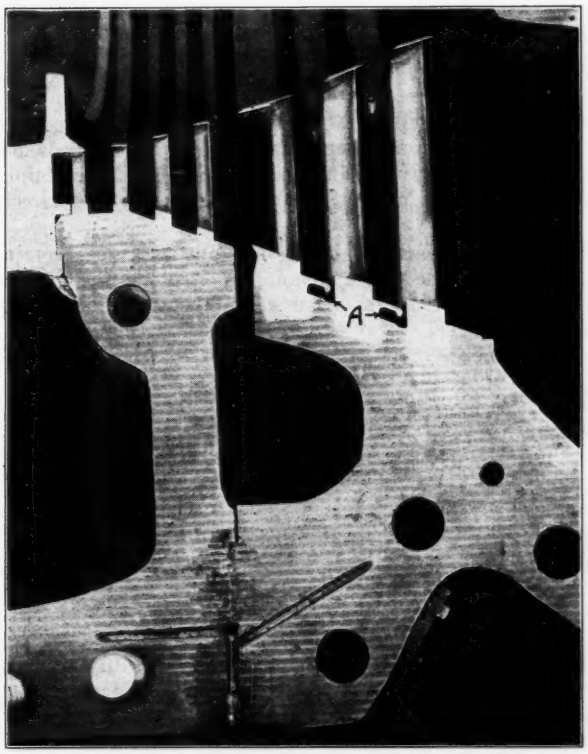


FIG. 4. SPECIAL GROOVES (A) FOR DRAINING MOISTURE FROM STEAM IN A BROWN BOVERI TURBINE

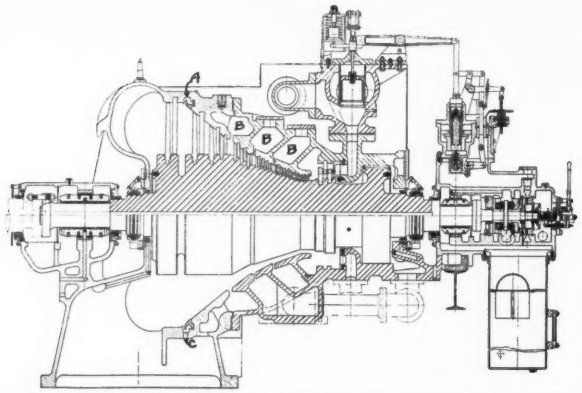


FIG. 5. PROVISION FOR DRAINAGE ON A 10,000-KW., 3600-R.P.M. WESTINGHOUSE TURBINE

ways. In the machine shown by Fig. 5, moisture from the entire periphery drains through C to the condenser. Figure 6 shows the cross section of a mercury turbine in which the peripheral grooves and drains from one stage to the other are clearly discernible.

Details of some of these drain passages as taken from Brown Boveri patent drawings are shown by Figs. 7A and 7B. The top view of Fig. 7A is a longitudinal section showing the passages, 16 and 18, through which the water drains to the collecting pipe 17. The bottom view of Fig. 7A is a cross section of the turbine shell showing different collecting channels. Figure 7B shows the special lip arrangement, 8, provided to prevent water thrown off the moving blades at the top of the casing from flowing or dropping back. Both of these drawings are more or less diagrammatic. Figure 7C shows the separation method and drain passages as used on the next to the last stage of a Zoelly turbine, somewhat similar to the construction shown by Fig. 6, the member D being the diaphragm between stages.

Extraction Points

It is, of course, difficult to determine the quantity of moisture actually separated out by these methods, but tests show increased efficiencies which can be explained only by assuming that the quantity drained off is considerable.

A few years ago when bleeding was just coming into favor, one of the advantages cited was the removal of moisture from the steam at these bleed points. Little

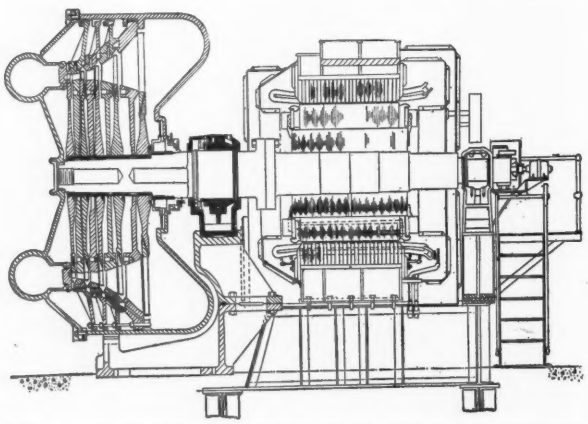


FIG. 6. PROVISION FOR LIQUID DRAINAGE IN A MERCURY TURBINE

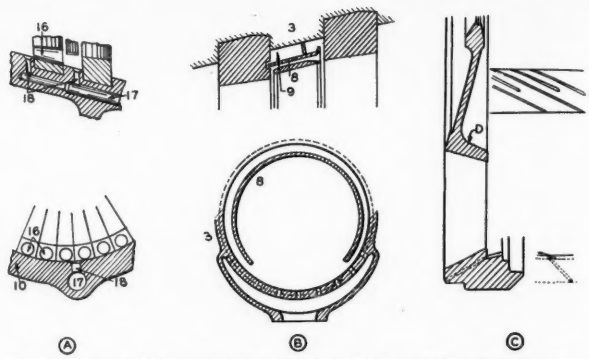


FIG. 7. A AND B. DIAGRAMMATIC ARRANGEMENTS FOR DRAINAGE TAKEN FROM BROWN BOVERI PATENT DRAWINGS. C. DRAIN PASSAGES ON A ZOELLY TURBINE

data are available either to substantiate or disprove these claims although there is some evidence, for instance slight pitting ahead of the bleed point and none on the next succeeding wheels,[3] that some moisture is taken out.

In many Westinghouse turbines, the steam extracted for feedheating is withdrawn through circumferential slots designed for a steam velocity of about 150 ft. per sec. so that the strong draft will tend to carry out a considerable amount of the moisture from the outer zones of the blade paths. Although it is evident that drain passages and extraction points can remove only the limited amount of moisture near to the cylinder wall, this removal serves to protect the tips of the blades.

The opinion has been expressed that anything approximating a complete separation of moisture in the low pressure stages is not a practical possibility because it would involve complicated and bulky separating elements and high pressure drops. Considering the fact that reheat has been extremely popular in spite of the expense, complication and pressure drops involved and that draining the water off offers practically the same advantage as shown by Fig. 4, further developments along this line are not beyond the realm of probability.

[3]Prime Movers Report N. E. L. A. proceedings 1927, p. 1170.

New orders for steel boilers, according to a recent report of the Bureau of Census, Department of Commerce, Washington, D. C., reached a total of 808 stationary units with 669,774 sq. ft. of heating surface in June, 1931. This total is subdivided by types as follows: water tube 88 boilers, 308,360 sq. ft.; horizontal return tubular 57 boilers, 77,751 sq. ft.; vertical fire tube 55 boilers, 12,197 sq. ft.; locomotive, not railway, 11 boilers, 9224 sq. ft.; steel heating as differentiated from power boilers, 535 boilers, 206,716 sq. ft.; oil country, 30 boilers, 34,845 sq. ft.; self-contained portable, 24 boilers, 17,262 sq. ft.; miscellaneous, 8 boilers, 3419 sq. ft. In addition to the above stationary boilers, there were sold 12 marine boilers with a heating surface of 9085 sq. ft., bringing the total of stationary and marine boilers to 820 units with 678,859 sq. ft. The total number of stationary steel boilers sold from January to June inclusive, 1931, was 3793 with a total heating surface of 3,575,261 sq. ft. as compared with 6320 sold in January to June inclusive, 1930, with a heating surface of 6,697,949 sq. ft. These figures are based on reports submitted to the Bureau of Census by 73 manufacturers.

Removal of Sulphur Dioxide from Flue Gases

Discussion of Experiments with Metallic Ions, Conducted Coöperatively by the University of Illinois and the Utilities Research Commission By H. F. Johnstone*

BETWEEN 70 and 90 per cent of the sulphur in coal appears in the flue gases after combustion, varying with the method of firing used. Of this portion approximately 97 per cent exists as sulphur dioxide and 3 per cent as sulphur trioxide or sulphuric acid vapor. These values correspond to an average concentration of about 0.325 per cent of the dioxide and 0.008 per cent of the trioxide in the gases from a high-sulphur coal. Because of these extremely small concentrations, the amount of water required for removal of the sulphur dioxide is enormous. Thus, it may be shown that, assuming no oxidation of the dissolved gas, for the removal of 75 per cent of the sulphur dioxide in the gases from 1 ton of coal containing 4 per cent sulphur, 21,000 gal. of water would be required; at 25 deg. C., 57,300 gal. would be required. When it is considered that many modern power plants burn as many as 4000 t. of coal a day, the stupendous volume of water required for washing the gases and the enormous size of the mechanical equipment for pumping and scrubbing become apparent.

Although in actual practice some oxidation of the dissolved sulphur dioxide by the oxygen from the flue gases takes place, the amount of water required approximates these figures. In the second report of the advisers to the London Power Co., it is shown that 44 per cent of the sulphur is removed from the gases from a 0.90 per cent sulphur coal when 27 t. of water (6750 gal.) are used per ton of coal. When the boiler is operating under half load, this amount is increased to 50 t. (12,500 gal.) per ton of coal for 67 per cent removal. The size of the scrubber can be gathered from the fact that 10.5 and 13 seconds' contact, respectively, are required to obtain these results. It was also noted in the experiments of the London Power Co. that, contrary to expectations, when hot water was used for washing the gases the efficiency of the scrubbing process was increased. For the same coal an average of 15.2 t. (3800 gal.) of water at 145 deg. F. (63 deg. C.) was required for 87 per cent removal. A striking feature of these tests was the absence of any odor of sulphur dioxide in the wash water.

It should be possible to increase further the capacity of the water for absorbing sulphur dioxide by introducing small amounts of catalysts to hasten the reaction between the dissolved gas and oxygen. Such catalysts have long been known.

Experimental Procedure

Air containing 0.325 per cent sulphur dioxide was passed at a constant rate through 3 liters of water containing the catalyst (Fig. 1). The gas was broken up into small bubbles by passing through a coarse porous plate. The fraction of the gas removed was determined by comparing the time required for neutralization of a known amount of standard sodium hydroxide solution containing hydrogen peroxide in a second tower with that required when no sulphur dioxide was removed. The efficiency of the scrubber was thus determined at short intervals and both the differential and cumulative efficiencies could be calculated. The sulphates of iron, manganese and nickel and various combinations of these and with copper, zinc, and chromium were used for catalysts. The concentrations varied from 0.028 to 4.2 grams of the metallic ion per liter.

Results

Results for iron and manganese ions are shown in Fig. 2. Nickel ions showed no catalytic effect in concentrations up to 1.5 grams per liter. The curves show that, in concentrations as low as 0.0028 per cent, manganese ions exert a strong catalytic action, increasing the capacity of the water for absorbing sulphur dioxide by approximately 600 per cent at this concentration. As the concentration of manganese ions is increased the effect of the increasing acidity of the solution on the catalysis is overcome. For a concentration of 0.03 per cent manganese an acid concentration of 29.6 per cent sulphuric acid may be attained before the differential efficiency falls to 30 per cent. During this time 3540 cu. ft. of gas per gallon were scrubbed with an average efficiency of 95.5 per cent.

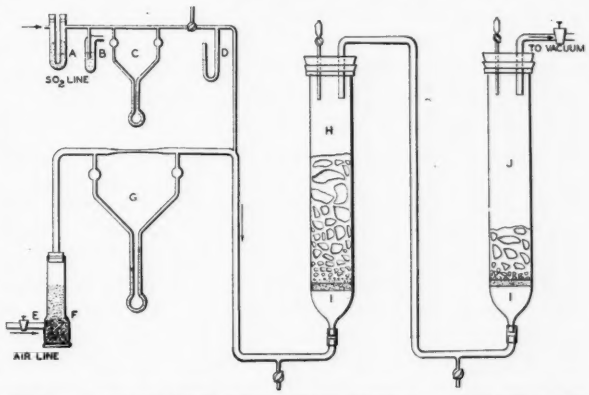


FIG. 1. APPARATUS FOR DETERMINING CATALYTIC EFFECT OF METALLIC IONS ON THE REMOVAL OF SULPHUR DIOXIDE FROM GASES BY WATER.
A—Drying tube containing anhydrone.
B—Pressure regulator containing sulphuric acid.
C—Flowmeter for sulphur dioxide; 25 to 100cc. per min.
D—Manometer.
E—Needle valve on compressed-air line.
F—Drying tube containing calcium chloride.
G—Flowmeter for air; 5 to 25 liters per minute.
H—Scrubbing tower containing washing solution.
I—Coarse porous plate.
J—Scrubbing tower containing standard sodium hydroxide solution, hydrogen, peroxide and indicator.

The catalytic effect of ferric ions is somewhat less than that of the manganese. Definite promoter action is shown when a very small concentration of manganese is added to dilute ferric solutions. In the case of iron salts as catalyst the capacity of the solution for dissolving sulphur dioxide is greatly increased by circulating the solution over scrap iron whereby the concentration

*Special Research Associate in chemical engineering. Abstracted from a paper presented before the American Chemical Society.

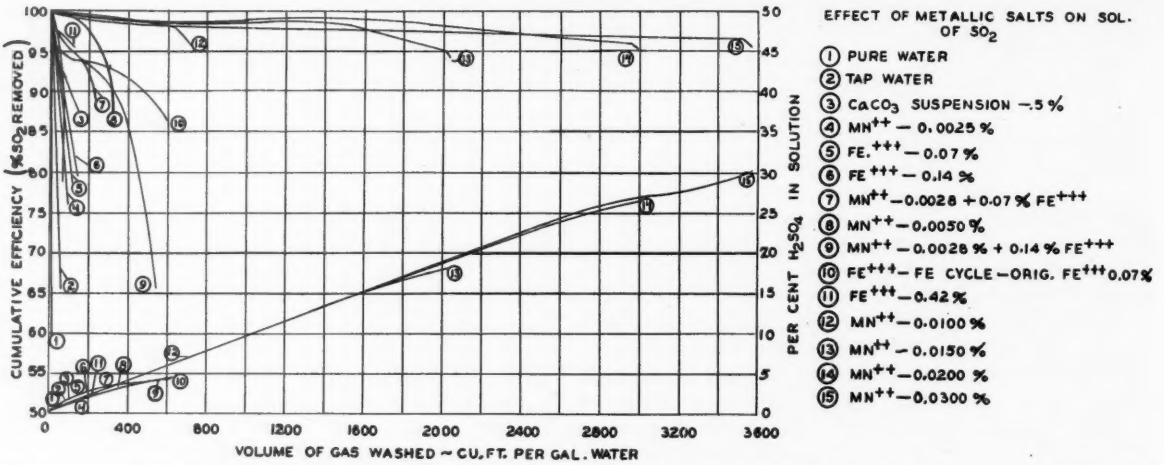

CUMULATIVE EFFICIENCY (%SO2 REMOVED)
PER CENT H2SO4 IN SOLUTION
VOLUME OF GAS WASHED ~ CU. FT. PER GAL. WATER
EFFECT OF METALLIC SALTS ON SOL. OF SO2
1 PURE WATER
2 TAP WATER
3 CaCO3 SUSPENSION —5 %
4 MN++ — 0.0025 %
5 FE.+++ — 0.07 %
6 FE+++ — 0.14 %
7 MN++ — 0.0028 + 0.07 % FE+++
8 MN++ — 0.0050 %
9 MN++ — 0.0028 % + 0.14 % FE+++
10 FE+++ — FE CYCLE — ORIG. FE+++ 0.07%
11 FE+++ — 0.42 %
12 MN++ — 0.0100 %
13 MN++ — 0.0150 %
14 MN++ — 0.0200 %
15 MN++ — 0.0300 %

FIG. 2. EFFECT OF METALLIC IONS ON THE CAPACITY OF WATER FOR ABSORBING SULPHUR DIOXIDE FROM AIR MIXTURES CONTAINING 0.325 PER CENT SULPHUR DIOXIDE.

of the catalyst is increased and that of the acid decreased.

Experiments Using Flue Gases

Application of the laboratory results was made with a small single-effect rotary scrubber having a capacity of about 100 cu. ft. per min. On account of the small capacity, the water used for washing was recirculated from a reservoir. The pump, valves and connecting piping were constructed of lead and the washer was lead-lined to prevent the attack of the acid. The flow of water was maintained constant at 8 gal. per min. Gases were drawn from the breeching of the university power plant after the air preheater. Since they were somewhat diluted by leaks in the blower, they entered the washer at about 250 deg. F. and having a composition of 5 per cent carbon dioxide, 15 per cent oxygen, 0.1 per cent sulphur dioxide.

The effect of the presence of manganese ions on the capacity of the washing water for absorbing sulphur dioxide is shown in Fig. 3. The initial concentration of manganese was 0.025 per cent, although it was increased somewhat by evaporation. The efficiency of the washer was determined by finding the sulphur dioxide-carbon dioxide ratio before and after the washer. This expedient was necessary in order to eliminate the effect of air leaks between the points of sampling and also the effect of fluctuations in the sulphur dioxide content of the gases. Although the efficiency of the washer operating

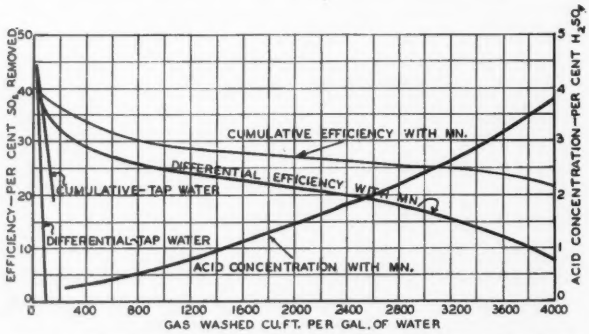


FIG. 3. EFFECT OF MANGANESE IONS ON CAPACITY OF WATER FOR ABSORBING SULPHUR DIOXIDE FROM FLUE GASES CONTAINING 0.1 PER CENT SULPHUR DIOXIDE AND 5 PER CENT CARBON DIOXIDE

on the flue gases was a great deal lower than that of the laboratory scrubber, it compared favorably with that obtained by other large scale methods. Furthermore, since the time of contact between the gas and liquid in this washer was of the order of only 1/20 sec., the great increase in efficiency per unit time is apparent. The results further show that with the catalyst the volume of water required is approximately 270 gal. (1¼ tons) per ton of coal.

Further work on the application of these catalysts to the removal of sulphur dioxide from flue gases is in progress.

The 24-in. natural-gas pipe line connecting Chicago and the Great Lakes region with the gas fields of the Texas Panhandle was completed September 1, by the Continental Construction Co. This line traverses six states, Texas, Oklahoma, Kansas, Nebraska, Iowa, Illinois; crosses 13 important rivers including the Canadian, Arkansas, Missouri, Des Moines and Mississippi and is more than 900 mi. long. Ten main line compressor stations, having a total of more than 70,000 hp. and located approximately 95 mi. apart, have been constructed to maintain proper pressure in the lines. These are located at Fritch, Tex.; Gray, Okla.; Bloom, Heizer and Glasco, Kansas; Beatrice, Neb.; Hastings, Truro and Harper, Iowa, and near Geneseo, Ill. A complete telephone system making communication possible from all points along the line, essential to the operation of such a system, has been installed. It consists of more than 1287 mi. of line using 5014 mi. of wire. Work on the gas line started only 13 mo. ago and has made rapid progress. This huge project in which the Cities Service, the Insull interests, Standard of New Jersey, the Texas Corp., Southwestern Development Co. and the Columbian Carbon Co. are jointly interested, will make available 175,000,000 cu. ft. of natural gas daily for industrial, commercial and domestic uses to Chicago and cities and towns along the line.

New orders booked for electrical goods during the second quarter of 1931 as reported to the Bureau of the Census by 84 manufacturers total $225,456,760 as compared with $182,485,841 for the first quarter of 1931 and to $292,902,071 for the second quarter of 1930.

Modern Sawmill Requires 9600 Kw. to Operate It

TWO PUBLIC UTILITY WATER POWER PLANTS AND THE COMPANY'S STEAM PLANT OPERATE TOGETHER TO SUPPLY THIS DEMAND

MILLING AND REMANUFACTURING plant of the Red River Lumber Co. is located at Westwood, California, at 5000 ft. elevation, in the northeastern part of the state and in the heart of the greatest stand of virgin white and sugar pine timber in the United States. This mill and remanufacturing plant is driven entirely by electricity with an individual motor on each machine and in many cases individual motors to drive each part of each machine.

This plant receives its power from three sources: Two hydroelectric units and one steam generating unit, as given below. Hat Creek power system consists of 56 mi. of 57,000-v. transmission line, running from Westwood to the generating plant of the Pacific Gas & Electric Co. on Hat Creek, which is connected with the Pitt River unit of that company. Power up to 10,000 hp. may be drawn from the Hat Creek unit free of charge, in exchange for valuable water rights which the company acquired in connection with its timber land. 2. Almanor hydroelectric station is connected to Westwood by eight miles of 33,000-v. transmission line. This unit contains two 2400-kw. units and a water supply, which, in addition to the constant flow from large springs, may also be obtained from a reservoir whose capacity is approximately 30,000 acre feet. 3. Steam generating plant, located at the Westwood plant, consists of a steam boiler plant, operated from mill refuse and delivering steam to four steam turbines with a maximum capacity of 5500 kw. This plant also supplies 3000 hp. of live steam to the dry kilns.

METHOD OF OPERATION

Normal operation of this plant depends upon the Hat Creek power. Power up to maximum allowed on this line is taken with all of our equipment on the line, operating as synchronous condensers but supplying no power to the line; however, when the power demand exceeds that which we are allowed over the Hat Creek line, the steam plant automatically picks up the additional load and, when this exceeds a certain value, it is manually transferred to the Almanor hydroelectric station up to the amount of normal flow of water to this plant, as the water in the reservoir is held entirely for emergency measures. In case of failure of the Hat Creek line, the plant may be operated by means of the steam-driven generators and the reservoir water for a period of 45 days, which is ample time to make repairs on any transformers or power line.

The Hat Creek power line runs through 56 mi. of deep snow country in the winter, practically uninhabited, making maintenance in the winter a serious problem. This line is patrolled by two 10-t. caterpillar tractors with snow tracks that operate through the six feet of snow encountered.

No attempt is made to control frequency as our power demand and supplies can not in any way materially affect the frequency of the great Pacific Gas and Electric System.

POWER DISTRIBUTION AND USE

Power is distributed throughout the plant from a 2300-v., 3-phase, 60-cycle system cut down to 440 v. for the majority of the machines in operation. A few, however, derive their power directly from the 2300-v. source. Some of this power is distributed at 33,000 v. through an automatic substation, eight miles from Westwood, where it is changed by two synchronous converters to 1500 v. d.c. for use on our electrified logging railway. The capacity of this substation is 1000 kw.

On the main line railroad, used in the logging operations, 17 mi. is electrified. The electric locomotives take their power from an overhead 1500-v. trolley line. The feature of this trolley is that it is offset from the center of the rail so as to allow extremely high logging equipment on flat cars, to pass freely. The maximum grade on this line is 1.85, compensated for curvatures. Two 65-ton electric locomotives operated in parallel deliver 20 carloads of logs to the mill at 2½-hr. intervals.

In addition to the standard motor load is the town lighting for the town of Westwood, power consumed in the electric furnace of the steel foundry, power consumed for a Ward-Leonard direct-current variable-speed drive on the peeler in the veneer plant and a frequency changing set increasing the frequency from 60 to 100 cycles for driving certain milling machinery at 6000 r.p.m.

The plant at Westwood normally employs 3000 men; when the logging operations are at their peak, during the summer, the employment often reaches 4000. The town of Westwood is entirely owned and operated by the Red River Lumber Co. and has a population of 6500.

The high power consumption of this plant is not due to the extreme size of its mill, which cuts approximately 800,000 board feet per day with two 10-hr. shifts but it is caused by the large amount of remanufacturing, which consists of production of moulding, box shook, veneer panels, sash and doors and cut stock.

The maximum power consumption at Westwood at present is over 8500 kw. with the load increasing each year with the installation of new machinery. This load, when added to the power line losses, makes the total power consumed to drive this operation, approximately 13,000 hp. or about 9600 kw.

Pittsfield to Build Largest Transformers

TRANSFORMERS that will exceed in weight and size the largest machines ever built at the Pittsfield, Mass., works of the General Electric Co. have been ordered by the Commonwealth Edison Co. of Chicago and the Super Power Co. of Illinois as part of an order for more than $1,000,000 worth of equipment. Delivery of the 20 transformers involved is expected early in 1932.

So large are eight of the units that special drop-frame transformer cars must be built to ship them. The transformers will be used on both ends of a new 220,000-v. transmission line, extending about 100 mi. from Powerton to the Crawford Avenue station of the Commonwealth Edison Co. at Chicago. For the receiving end, four 67,500-kv-a. power transformers and four 50,000-kv-a. regulating transformers will be required. At the sending end of the line there will be four 60,000-kv-a. units and eight 30,000-kv-a. regulating transformers.

Water Injection in Semi-Diesel Cylinders

By D. J. Altizer

IN OUR TOWN an old style semi-Diesel engine of a type that was built about 20 yr. ago furnishes power for a woodworking factory. The compression pressure of this engine is about 80 lb. per sq. in. and the fuel charge is drawn in just as the piston starts on the compression stroke. A hot bulb produces ignition. This method of ignition, combined with the early fuel injection and the fact that the engineer tries to get along without the water injection for which the engine was designed, seems to be responsible for a most annoying operating difficulty. When heavily loaded, the engine emits a detonation or pound that can be heard half a mile away. The operator's reason for stopping the water injection is that the bulb temperature falls so low at light loads that ignition becomes erratic and sometimes fails to occur at all.

While engines designed for compression pressures as low as the above are seldom built nowadays, still many of those built in former years are in use.

In oil engines operating under a compression pressure below 100 lb. or so, considerable time must be allowed for gasification and ignition of the charge. The fuel oil must be introduced into the cylinder, therefore, early in the compression stroke and the problem then is to prevent pre-ignition under heavy loads and to make ignition certain under light loads.

It is assumed that maintaining a constant bulb temperature for all loads will do this and to secure this uniformity of temperature, the early designers hit on the scheme of injecting a small quantity of water into the cylinder at the end of the power stroke. Evaporation of this water is intended to absorb heat from the hot piston and cylinder wall and to keep the temperature of the bulb and charge of fresh air from going too high. By proportioning the water injection to the load, it is expected that the bulb temperature will stay fairly uniform under all loads. The water feeder is designed to vary the quantity of water injected into the cylinder automatically in accordance with the load but, as this quantity depends largely on the heat given off by the piston and cylinder, which is not always proportional to the load, automatic water-feeding attachments cannot be expected to work reliably without thermostatic control. Rigging a thermostat for this purpose involves complications that would better be avoided.

Effect of Water Injection

Water does free the cylinder of carbon and for this reason its occasional use is advantageous even in engines designed for dry running. Operating the engine with some water in the mixture for about a half hour each day is sufficient, however. The water evaporates into steam which acts chemically on the red hot deposits of amorphous carbon or soot in the exhaust port and produces water gas, which passes out with the exhaust. A steady injection of water, however, should not be indispensable to operation.

The simplest thing to do, of course, to obviate this difficulty, is to use an engine designed for a dry mixture and employing comparatively high compression, say 125 to 275 lb. per sq. in. With such a high compression, it is possible to burn cheaper grades of fuel than can be handled by low compression engines designed for wet mixture. A tarry residue is often found in the exhaust of wet-mixture engines running on an inferior grade of fuel but this is not so when the compression is relatively high and the mixture dry.

Some engineers, of course, persist in using water jets for steady running, even with medium compression engines. It is conceivable, even with such engines, that some admixture of water might improve operation and such engines might be equipped with a bleeder valve for emergency use. Some fuels may tend to gum up the pistons and this trouble may be prevented by judicious injection of water. In general, however, with medium and high compression engines, such measures are not necessary.

Medium compression semi-Diesel engines using a dry mixture not only burn the fuel cleaner than do wet-mixture engines but also consume less fuel per unit of output. These engines also do not tend to race as do some of the low-compression, wet-mixture engines. In many industries for which the semi-Diesel engine is suited, the load is extremely variable, either all on or all off. Experience has indicated that a well built dry-mixture engine will handle such loads with little difficulty.

Results of a survey by counties of Michigan farms having electric light and power service recently completed by the statistical research department of the National Electric Light Association are announced by the Utilities Information Bureau of Michigan. The survey is based upon United States census data and upon reports from Michigan utilities.

The survey, made as of August 31, 1930, shows that upon that date Michigan had 27,677 farms with electric service, out of a total of 169,915 farms in the state; 78 counties out of a total of 83 reported electrified farms and only five reported no farms with electric service,—Alcona, Iosco, Keweenaw, Montmorency and Oscoda.

Macomb County, according to the survey, leads the state both in the number of farms with electricity and in the percentage of electrified farms. It had at the time of the survey 2372 electrified farms or 80.2 per cent of a total of 2957 farms. In percentage of farms electrified, the leading counties rank as follows: Macomb, 80.2 per cent; Washtenaw, 55.3; Wayne, 52.1; Dickinson, 50.4; Monroe, 47.1; Oakland, 41.3; St. Clair, 37.4; Iron, 37.2; Ottawa, 35.9; Delta, 35.1.

While farm electrification has advanced particularly rapidly among the southeastern counties, it is interesting to note that three Upper Peninsula counties, Dickinson, Delta and Iron, are among the 10 leaders as regards the percentage of farms with electric power.

Extension of farm lines has gone forward strongly during the past year with an estimated increase of more than 3000 farm customers, so some counties can show at the present time considerable gains over the figures obtained in the survey.

Air filters on Diesel engines must be kept reasonably clean or they will decrease the air supply to the engine and interfere with combustion. The economy of a clean air filter for this service is unquestioned.

This squirrel cage induction motor is the least complicated mechanically of any type of motor made. Yet by slight changes in rotor and stator windings it can be given a wide and varied range of operating characteristics

SELECTING THE INDUCTION MOTOR

By PAUL W. ARNOLD
Development Engineer, The Reliance Electric & Engineering Corporation.

SQUIRREL CAGE MOTORS may be divided into various groups and classifications. For this study, however, they will be classified according to torque and starting current characteristics which are of prime importance in motor selection. A clear and concise knowledge of squirrel cage torque characteristics makes possible the selection of motors which will not be over or undersize and which will perform as desired under certain sets of circumstances.

If too large a motor is selected, it will run underloaded with a resultant low power factor and efficiency and will also be high in installation cost. If too small a motor or one with the wrong torque characteristic is selected, it will be found to perform poorly, overheat, possibly stall or burn out. In any event, it is important that the proper motor be selected from the standpoint of first cost, operating cost, maintenance cost and possible production loss.

The starting current of motors is important as it decides the type of starting equipment which will be required. Power companies in general rule that motors over 5 hp. should be started with reduced voltage starting equipment. If a plant manufactures its own power, it is not governed by power company rules but it must install power lines which are large enough to carry the maximum demand currents.

Figure 1 shows diagrammatically the two general divisions of squirrel cage motors with five subdivisions.

First study these two divisions from the standpoint of torque. Thus far only starting torque has been mentioned. In addition to this, the maximum or pullout torque must be considered. This pullout or maximum torque, as the term would indicate, is the greatest torque that motor will develop. If a greater load or torque is imposed on the motor, it will stall.

Torque characteristics of these five groups can best be illustrated by curves, showing the amount of torque developed at all speeds from zero to synchronous. The

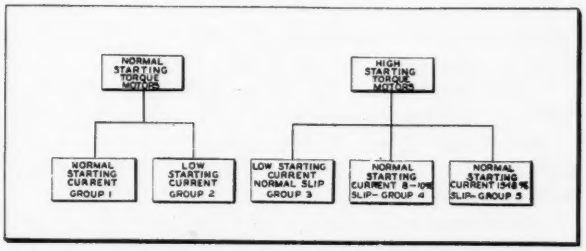

NORMAL STARTING TORQUE MOTORS
HIGH STARTING TORQUE MOTORS
NORMAL STARTING CURRENT GROUP 1
LOW STARTING CURRENT GROUP 2
LOW STARTING CURRENT NORMAL SLIP GROUP 3
NORMAL STARTING CURRENT 8-10% SLIP- GROUP 4
NORMAL STARTING CURRENT 13-18% SLIP- GROUP 5

FIG. 1. SQUIRREL CAGE MOTORS ARE CLASSIFIED ACCORDING TO STARTING TORQUE, STARTING CURRENT AND SLIP

percentages shown are illustrative only and will vary for motors of different speeds. It will be noted that the "full load" torque line intersects each of the speed torque curves at different points. The point of intersections indicates the percentage slip or speed drop from synchronous speed.

Curve No. 1, Fig. 2 shows the torque characteristics of normal starting current motors when connected directly to the line. Curve 1A shows the characteristics of the same motor if started with an 80 per cent tap compensator. Point A on this curve represents the point at which the motor is thrown from 80 per cent voltage to full voltage. This operation likely will not always occur at the point indicated, especially if the

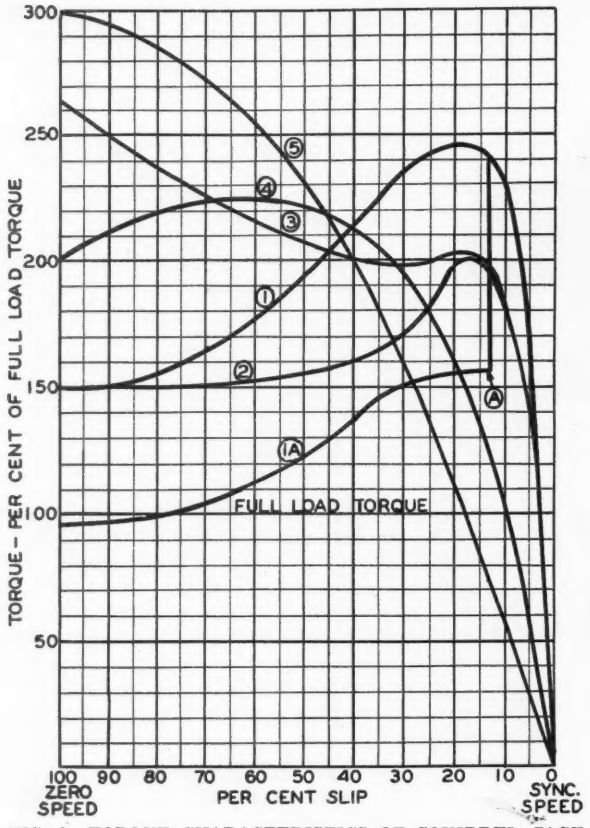


FIG. 2. TORQUE CHARACTERISTICS OF SQUIRREL CAGE MOTORS

Curve No. 1. Normal starting torque, normal starting current full voltage start. Curve No. 1A. Normal starting torque, normal starting current started on 80 per cent tap compensator. Curve No. 2. Normal starting torque, low starting current full voltage start. Curve No. 3. High starting torque, low starting current, normal slip full voltage start. Curve No. 4. Semi-high starting torque, normal starting current 8 to 10 per cent slip full voltage start. Curve No. 5. High starting torque, normal starting current 15 to 18 per cent slip full voltage start.

starter is manually operated, in which case the transfer depends entirely on the operator.

Curve No. 2 shows the torque characteristics which may be expected of a low starting current motor of the normal torque type. The maximum torque is not as high as shown on curve 1 but is materially higher than that shown by curve 1A.

The motors described in the foregoing will be satisfactory for 90 per cent of all requirements. The low starting current and normal starting current motors may be considered interchangeable as far as application is concerned. The only applications for which the low starting current across-the-line motor would not be satisfactory are those for which the higher starting torque might be damaging. This case is very rare and in general the high starting torque is a desirable feature.

Curve No. 3 of Fig. 2 shows the torque characteristics of a high torque, low starting current, normal slip motor. (Normal slip means a slip of 3 to 4 per cent.) The most important thing to note in this curve is the low pullout torque. Because of this feature there are certain applications for which this type of motor is not satisfactory. This is true of applications where the starting load is largely frictional. These motors are applicable to pumps, compressors, certain conveyors, that is to loads which require a high starting torque to break them loose. These low slip, high torque motors are not satisfactory for application to flywheel loads, as the low slip does not provide the necessary cushioning effect.

Curve No. 4 of Fig. 2 shows the torque characteristics of semi-high slip motor with a high starting torque for continuous operation. This type of motor is that which is frequently termed a punch press motor. It can be easily seen that when these motors are developing less than full load torque, which is frequently the case, slip will be less than 10 per cent, according to curve 4. When the load is increased, the motor slows down, which allows the inertia of a flywheel to carry the peak load. This reduces the size of motor which is required, also materially reducing the load current peaks which would occur if the flywheel were not allowed to function naturally.

Consider, for example, that a slow operating punch press requires a 10-hp. motor. It is likely that this motor has been selected because it will develop about

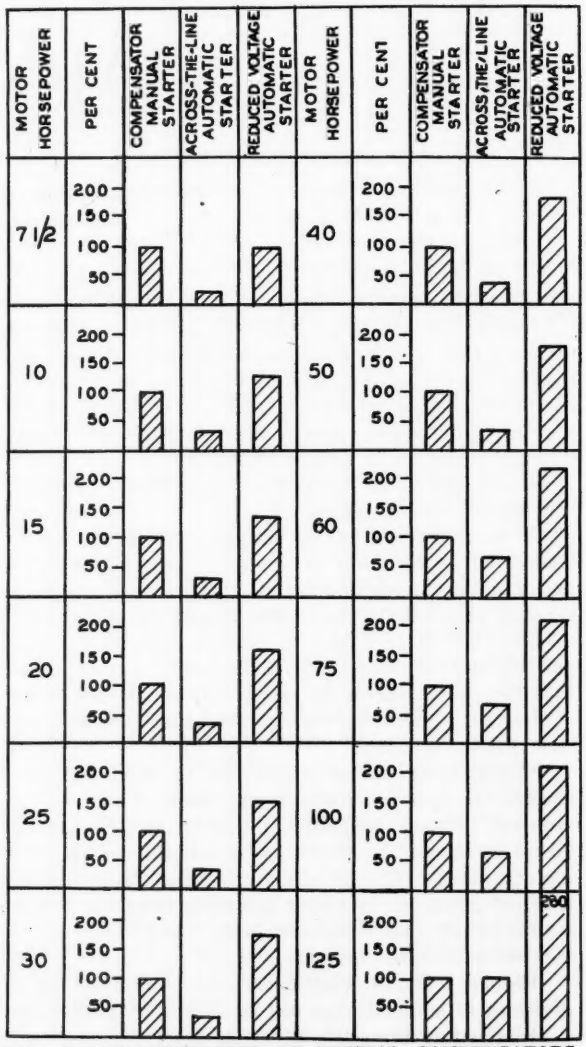


FIG. 3. RELATIVE COST OF MANUAL COMPENSATORS, ACROSS-THE-LINE AUTOMATIC STARTERS, AND REDUCED VOLTAGE AUTOMATIC STARTERS

The manual starter is given a value of 100 per cent and others shown in relative percentages. The figures are applicable to 440 v. control. Variations will be about the same at other voltages.

15 hp. at starting, though possibly only 5 to 7½ hp. is required when the punch press is running. In such cases, if a semi-high slip motor with 200 to 225 per cent starting torque had been selected, a motor capable of developing 6 to 7½ hp. only would be required for the high starting torque and would provide the 15-hp. starting torque. This means a saving in first cost. Next, the motor will be operating at very near its full load all of the time, which means at its maximum efficiency and power factor. The 10-hp. motor first mentioned would always operate under loaded and it is a well known fact that efficiency and power factor decrease very rapidly with a decrease in load. Even considering that the efficiency of the high torque punch press motors is lower than of the normal torque motor at full load, it is probable that its operating efficiency would be higher as its loss in efficiency due to underload would more than offset its natural difference.

Curve No. 5 illustrates the torque characteristics of high torque high slip motors (15 to 18 per cent slip).

These motors will not operate continuously as the heating in the high resistance rotor used would cause the motor to burn out. It can be readily seen from curve No. 5 that these motors are designed to develop their maximum torque at starting. High torque high slip motors are used for driving cranes, hoists, and other machines for a high starting torque and intermittent operation.

The second general consideration is that of the starting current. Practically all power companies allow motors of any kind, 5-hp. and smaller, to be thrown directly on the line. Larger motors must be started by means of reduced-voltage starting equipment unless they are of the low starting current type. In general, motors 7½ to 30-hp. with starting inrush currents within N.E.L.A. recommendations can be obtained. Larger motors of the low starting current type are made but starting currents are over N.E.L.A. recommendations.

The N.E.L.A. recommendations for starting currents mentioned above are listed in the accompanying table. These limits set up by the National Electric Light Association provide that if the locked rotor current of a squirrel cage motor exceed these values for a given horsepower it should not be thrown on the line. Practically all power companies recognize the recommendation and permit low starting current motors to be thrown directly on the line. There are in-rush current recommendations for motors over 30-hp. but these are so low that it is then impossible to build motors without a great sacrifice in torque. These N.E.L.A. recommendations require starting currents to be within about 330 per cent of full load current. Normal starting current motors require from six to eight times full load current at starting and low starting current motors over 30-hp. can be obtained with starting currents which are 450 to 500 per cent of full load, which can be thrown direct on the line.

N. E. L. A. RECOMMENDATIONS FOR INDUCTION WATER STARTING CURRENTS. MOTORS HAVING STARTING CURRENTS WITHIN THEIR LIMITS MAY BE THROWN DIRECTLY ON THE LINE IN PRACTICALLY ALL CASES

	STARTING CURRENT				
	220 V.		440 V.		550 V.
H. P.	3 Ph.	2 Ph.	3 Ph.	2 Ph.	3 Ph.
7½	115	98.6	58	50	46
10	141	123	70.5	61.5	56
15	197	171	98.5	85.5	78.6
20	251	222	125	111	101
25	304	270	152	135	122
30	360	320	180	160	144

Now, what does this mean in the way of control saving? Here, again, the situation can be best illustrated by a chart. (Fig. 3.) The cost of a reduced voltage manual starter is indicated as 100 and the cost of an automatic across-the-line starter and automatic reduced voltage starter is shown in proportion. It is at once evident that an automatic across-the-line starter is far less expensive that even a manual reduced voltage starter. Automatic starting, remote control, lower maintenance due to simplicity, are obtained not at a higher, but a lower cost. The low starting current motors cost about 5 per cent more than the normal starting current but this cost is offset by savings in control.

The high torque motors shown in group 4 and 5 of Fig. 2 are indicated as normal starting current. This is somewhat deceiving as their starting currents are not greatly over N.E.L.A. recommendations, in fact these motors are generally thrown directly on the line.

Figure 4 gives a comprehensive picture of the characteristics of these five groups of motors from the standpoint of torque, starting current, efficiency, power factor, slip and cost.

Applications of squirrel cage motors should be carefully studied. A motor of proper size and characteristics should be selected. The squirrel cage motor is the least complicated mechanically of any type of motor that is manufactured, yet its characteristics can be widely varied, should be well undersood and applied.

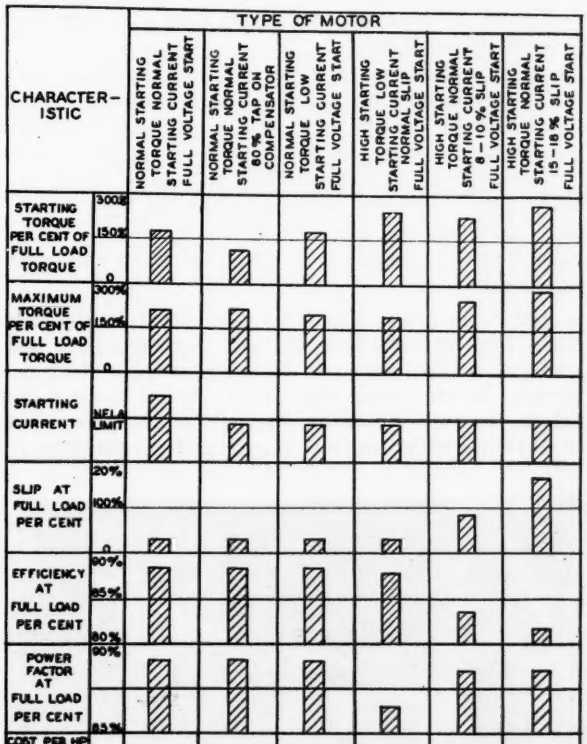

TYPE OF MOTOR
CHARACTERISTIC
NORMAL STARTING TORQUE NORMAL STARTING CURRENT FULL VOLTAGE START
NORMAL STARTING TORQUE NORMAL STARTING CURRENT 80% TAP ON COMPENSATOR
NORMAL STARTING TORQUE LOW STARTING CURRENT FULL VOLTAGE START
HIGH STARTING TORQUE LOW STARTING CURRENT NORMAL SLIP FULL VOLTAGE START
HIGH STARTING TORQUE NORMAL STARTING CURRENT 8-10% SLIP FULL VOLTAGE START
HIGH STARTING TORQUE NORMAL STARTING CURRENT 15-18% SLIP FULL VOLTAGE START
STARTING TORQUE PER CENT OF FULL LOAD TORQUE
300%
150%
0
MAXIMUM TORQUE PER CENT OF FULL LOAD TORQUE
300%
150%
0
STARTING CURRENT
N.E.L.A. LIMIT
SLIP AT FULL LOAD PER CENT
20%
100%
0
EFFICIENCY AT FULL LOAD PER CENT
90%
85%
80%
POWER FACTOR AT FULL LOAD PER CENT
90%
85%
COST PER HP WITH STARTER
FIGURES AVERAGE 7½-75 HP 1800 RPM

FIG. 4. GENERAL COMPARISON OF THE MORE IMPORTANT FACTS PERTAINING TO SQUIRREL CAGE MOTORS

The figures are average for 7½ to 75-hp., 1800-r.p.m. motors. The ratios at other speeds and capacities will be practically unchanged.

A Strenuous STEAM ENGINE Repair Job

Part II.* Patterns for new valves made, new valves cast and machined; crossheads turned and eccentrics machined under difficulties

By *George H. Wallace*

IT WAS THE INTENTION of the owner to do as much as possible of the repair work in their own shop, or at least in the town, in order to keep local help in employment. This was commendable, though in a few instances new parts had to be obtained from the engine builder.

The local carpenter was called upon to make patterns for the new low-pressure valves. The task brought out new ideas in wood working and also added numerous wrinkles to the pattern maker's countenance. These valves were cast in a local foundry, but being a new idea there also, spoiled two castings. The iron was of good quality, however.

These valves were turned up on a lathe that was badly worn on the ways and while identical at the ends, the valves were 0.080 in. larger in the middle. This required careful manipulation of the tool, tapping the cross feed in, or out, until the desired result was obtained.

As the inlet valves were not a full circle throughout, like the exhaust valves, studs were screwed in the back at intervals of six inches to facilitate accurate measurements. As no micrometers were available to measure the diameter of the valves, crossheads, or the new eccentrics, it was necessary to make them on the job.

Valves Lapped in

Yokes of suitable steel for each size, were forged, and screws of 20 threads to the inch used. These crude, though efficient outside micrometers were set to zero with an inside instrument, and very close measurements secured. The ports in the cylinders were lapped with a convenient mandrel, turned down for successive sizes of ports, and later the valves themselves were lapped into the ports, making an excellent job.

After turning the valves in the lathe, they were sent to the planer, and the slots for the valve stem heads machined to standard size, and within 0.002 in. of perfection, which was very close under the circumstances. As early as possible, a boring bar was secured and work started on reboring of the steam and exhaust ports. While not of identical size, these were approximately 16¼ in. in diameter.

All the valve stems were worn on the heads and where the packing had cut in. The stems were turned down a small amount, built up where needed, and all remachined to standard sizes. Since the stem slots in the new valves did not coincide with those in the old ones, it was necessary to weld up the old keyways, return the stems and lay out keyways anew. New keys were forged to replace old ones that were no longer serviceable.

Later on, after the valves were fitted to the new ports, they were scribed for their working edges, and returned to the planer to have the surplus stock removed. In machining the curved edge of the exhaust valves, the valve was held crossways of the planer bed in V-blocks with suitable clamps, and turned slightly

*See p. 901, Sept. 1, 1931, issue for Part I.

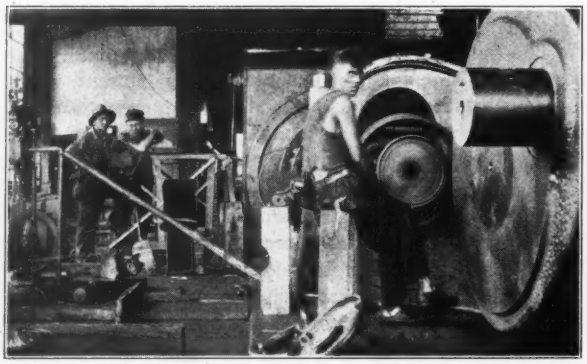


FIG. 3. BORING BAR WAS DRIVEN BY THE SMALL ENGINE AT THE LEFT

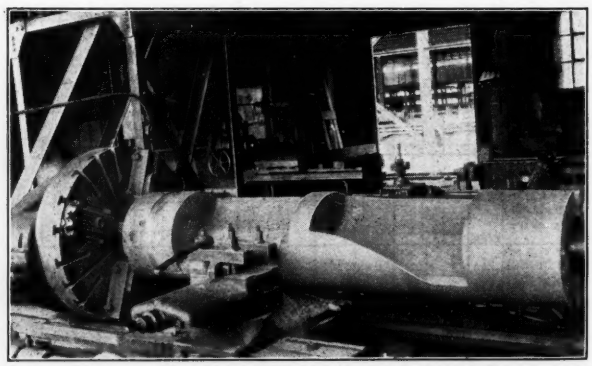


FIG. 4. TURNING A 16 BY 84 IN. EXHAUST VALVE IN A LATHE 0.040 IN. OUT OF PARALLEL.

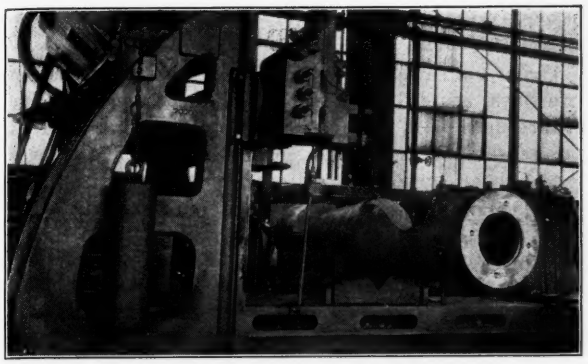


FIG. 5. MACHINING THE CURVED EDGE OF THE EXHAUST VALVE ON A PLANER.

from time to time, in order that the tool would cut as near radially as possible.

At some time in the past, probably before the engine was brought to its present location, trouble had been experienced with the side rods, and new ones, made of 4 in. extra heavy pipe had been welded and riveted to the keyheads evidently with little regard to proper length. When checking up the travel of the valves and wristplates, it was found that the steam and exhaust side rods were 13/16 and 1-1/16 in. too short, respectively, for proper travel. These were cut in two in the middle and new sleeves, made out of old anti-aircraft guns, were inserted, shrunk in and riveted.

Although the low pressure eccentrics had no part in the accident, years of use had worn both the straps and the eccentrics in the direction of thrust a total on both strap and cam of from 0.140 to 0.240 in. They were not only noisy but were rapidly wearing towards the useless point from day to day.

The only boring mill that would swing the straps, in that section of the country, was located in an old shop several miles out. Its years of service were many but it was not only the best, but the only machine available. The straps were put on the planer and an eighth of an inch faced off at the joints, after which they were bolted together with proper shimming, taken out to this old boring mill, and rebored until they would clean up.

New Eccentrics Cast

Patterns were made for new eccentric blocks, 6 in. wide and approximately 40 and 44 in. finished diameter. They were cast locally, faced on the planer and slotted for companion keys. The only tap suitable for the keyed studs was a 2-5/32-in., 12-thread tap that had been an heirloom for a long time.

It served its purpose, however, and holes were drilled and tapped in one-half of the eccentrics and studs made to fit suitable holes in the other halves, with slots for ½-in. wedge keys to clamp the halves together. With the eccentrics assembled, they were also taken to the country boring mill, turned to fit their respective straps with proper clearance, and bored for a sliding fit on the 26-in. shaft.

Since the engine operated 12 hr. a day, the fitting of the new eccentrics to the shaft had to be done after 6 p. m. and, whatever work was undertaken, it had to be completed, or entirely removed, and the oil guard put on again, ready for the next day's run. Though much of this work was done with the thermometer in the power plant registering from 110 to 120, or even 125 deg. F., the eccentrics were finally connected to their carrier arms and idled along with the engine, getting nicely smoothed up.

Old telescopic oilers and tubing were all practically worn out and liable to cause future trouble so patterns were made, new tubing bought and new oilers made on the job. While this incidental work was being done, the electric welders had completed welding the broken frame and had started on the broken exhaust chest. Other gangs, in the meantime, had chipped out all the grouting from under the cylinder so the cracks could be chipped clear through from inside the chest.

To repair a spot where the broken lug had taken part of the wall of the chest with it a pattern was made, approximately 26 by 32 in. and 1½ in. thick, with a new lug attached. After a small amount of machine work, this was riveted over the hole and then welded inside and outside.

To enable repaired parts to withstand external pressure under vacuum, steel bars 1 by 7 in. and 36 in. long, were "stitched" to the inside braces of the exhaust chest, and 1¼ in. rods of a length to be a snug fit were put in to brace the walls and welded at both ends.

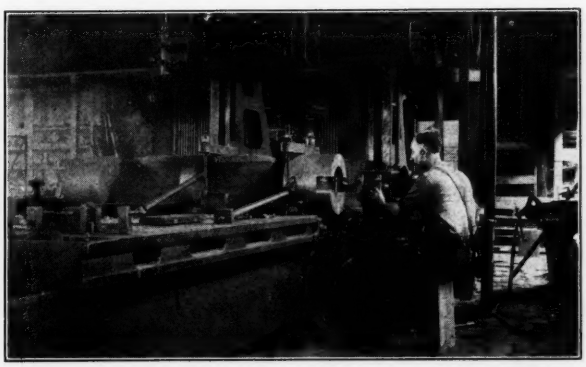


FIG. 6. SLOTTING VALVES FOR THE STEM T-HEADS.

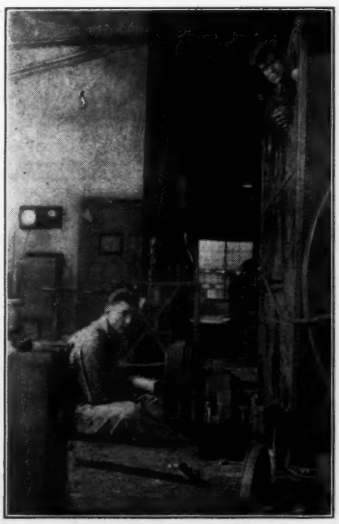


FIG. 7. REBORING A 16-IN. EXHAUST PORT ON A 70-IN. CYLINDER. NOTE THE MAN IN THE UPPER PORT.

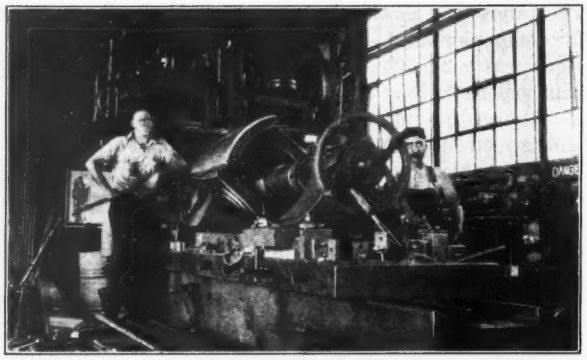


FIG. 8. WHITTLING A CROSSHEAD DOWN IN A PLANER TILL IT WOULD SWING IN THE LATHE.

Having rebored the crosshead slide, it was necessary to rebabbitt the shoes. This was done at the plant by setting each shoe in turn into a sheet steel form of proper radius, with allowance for turning. A mandrel was made from an old locomotive axle and screwed into the crosshead backwards and the jam nut locked. Then it was discovered that the largest lathe in that section of the country was too small to swing it.

Two massive tailstocks from old roll lathes were dug out of the discard and blocked up to suitable height on the planer bed and accurately lined and leveled. The crosshead on its mandrel was swung between these centers and a finishing tool set vertically over the center of the mandrel. The crosshead was then rotated manually as desired, and the tool fed down till both shoes were turned down to about ⅛ in. oversize, where it was possible to swing them in the lathe for the finishing cut. The tail shoe was also rebabbited, and turned in the lathe on a mandrel made from a conveniently sized cast-iron roller.

While the tail slide was badly broken, the slide itself was intact. The adjustable base was repaired by wrapping it with an 8-in. channel iron with the top flange cut off and riveted to what was left of the casting. Suitable bosses were welded on for the adjusting screws, and it again fulfilled its duty.

The crankpin babbit was badly cracked, so it was faced off and shimmed out to normal size. The adjusting wedge was not only badly worn, but was hammered into the hole in the end of the rod. It was necessary to rebore the hole to clean it up and make a new wedge, 3/16 in. over the original 4-in. size, out of the inevitable locomotive axle. New 2-in., 12-thread adjusting screws were also made.

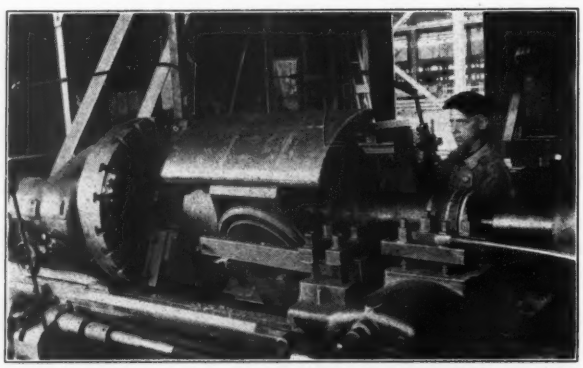


FIG. 9. THE FINISHING CUT ON A 36 IN. CROSSHEAD

Later on, after the engine had been in operation two days, an old crack in one of the crosshead wedge collars developed, and broke at 9 a. m. This relieved the tension on the wedge, which came out, and was tossed about considerably before the engine was stopped.

Entire New Wedge Made

An entire new wedge was made from another section of a locomotive axle. Two more new 2-in., 12-thread adjusting screws were also made. Material for new collars was finally located in some spare steel couplings for a 200-hp. motor, which served the purpose admirably with a minimum of machine work, except that they had to be bushed to accommodate the 2-in. screws. The new parts were completed and assembled at 5:15 in the morning, and at 5:30 the engine was put in service on schedule.

The 4-in. valve stems had been built up where worn by the packing and re-turned, so it was necessary to make new metallic packing for them. Since the casings were also worn, they were all remachined, the joints ground and the babbit segments made to suit. In all, 18 sets of this packing were made on the entire job and all proved successful.

Naturally, with new steam and exhaust valves and the old keyways welded up, new keyways were laid out the same as on a new job, with the valves set for the necessary lap or port opening, according to judgment. Being a double eccentric design, considerable latitude was permissible.

More Current Through a Tube than a Rod

A HOLLOW COPPER tube of the proper wall thickness will carry a 60-cycle current with 10 per cent less heat loss than a solid rod of the same diameter.

A conductor carrying current may be thought of as made of an infinite number of separate, parallel conductors, each carrying a portion of the current. As is the habit of parallel conductors carrying current of varying magnitude, each conductor has an inductive influence on all of its neighbors. The net result is that although the current in the hypothetical conductors close to the periphery of the conductor is in phase with the internal voltage the currents in the conductors as the center is approached are more and more out of phase with the voltage. It is quite possible in conductors of large diameter that the current flowing near the center is as much as 180 deg. out of phase with that flowing near the edge. This results in what might be called a circulating current, whose practical effect is to increase the heat loss of the conductor. Eliminating this circulating current by making the conductor hollow reduces this loss.

The wall thickness for minimum heat loss is for all practical purposes independent of the conductor diameter and is dependent almost solely upon the frequency of the current carried. Thus, for 60-cycle alternating current and copper of 97 per cent conductivity, the wall thickness should be about ½ in., whether the outside diameter is 1 or 8 in.—Electrical Journal.

A Policy for Power Plant Development

(*Continued from page 969*)

cents point of view and being favored from the operating viewpoint and easily adapted to progressive development it was chosen.

The financial comparison of the Schemes, as worked out, was:

	Increase in Investment above required minimum	Annual saving in cost for Power and Steam by Increased Investment
Scheme 1	Zero	Zero
Scheme 2	$ 48,000	$ 9,500 minus
Scheme 3	185,000	56,500
Scheme 1-A	Zero	Zero
Scheme 1-B	$ 39,000	$ 1,100
Scheme 3-A	149,000	31,200

Execution of the Plan

At the present writing, the mill changes and the remodeling of the power and steam supply, both as contemplated in 1928, have been completed. The mill changes were made in the order anticipated. The changes in the power and steam supply were made progressively in three undertakings to develop the plan outlined in Scheme 3.

The first undertaking was the installation of two 400-lb. pressure, stoker fired boilers and the relocation of the 1250-kv-a. condensing steam turbine generator equipped with bleeder gear and piped to the paper machines. The new boilers were installed one at a time, it being necessary to remove two old boilers and install one new boiler unit, put it in operation, and then remove two more old boilers and install the second new boiler.

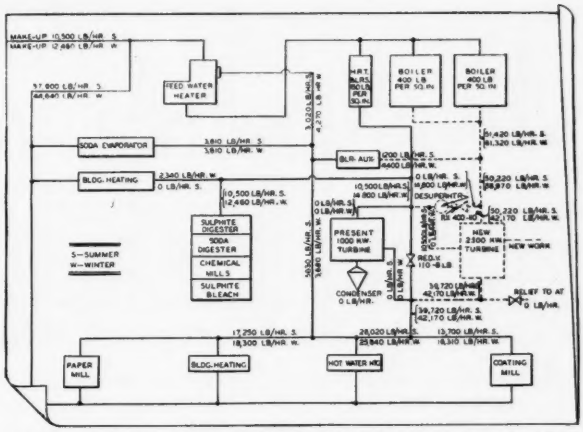


FIG. 8. STEAM DISTRIBUTION DIAGRAM WITH PROPOSED 2500-KW. TURBO-GENERATOR

All changes were made and this part of the program completed with both new boilers operating in May, 1929. The new paper machine was put into operation about a month earlier and about two months after the first new boiler was in service.

Experience with operation showed economy by running the 1250-kv-a. turbine at a load such that with the steam for the paper machines taken from the bleeder, only enough steam passed to the condenser to keep the lower stages safely cooled. The plant was operated in this manner at 150-lb. boiler pressure until recently.

In the summer of 1930, about a year after the new boilers were put into service and the new paper machine installed, the load on the Filer & Stowell engine was reduced by motor-driving some calenders. This decreased

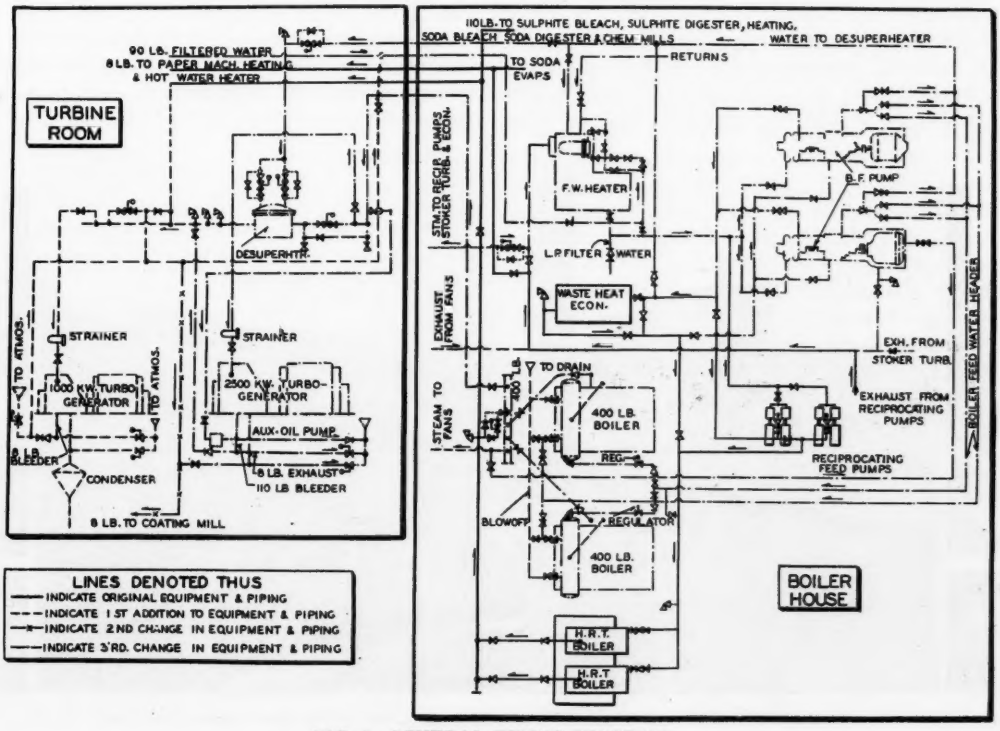


FIG. 9. GENERAL PIPING DIAGRAM

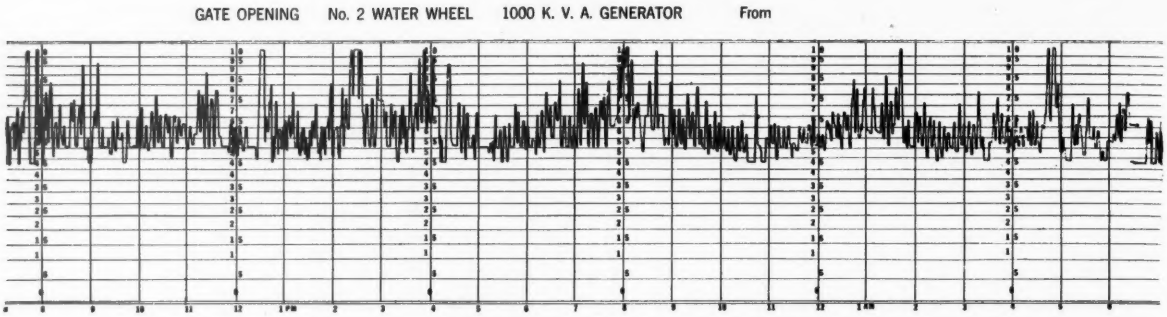


FIG. 10. CHART FROM GATE OPENING RECORDER, NO. 2 WATER WHEEL, AUG. 27 TO AUG. 28, 1931

the amount of exhaust steam available from the engine. To make up this exhaust from the 1250-kv-a. turbine, this machine was piped to the coating mill low pressure system. This line (shown in photograph Fig. 11) completed the low-pressure piping system and was the second step in the development of the original plan.

Early in 1931, plans were made to abandon the Filer & Stowell engine mechanical drives. This was anticipated by the original plan, which called for the installation of a 2500-kw. steam turbo-generator and a boiler pressure of 400 lb. to meet the changed conditions.

Before undertaking this, the last step in the original power development plan, it seemed advisable to check the earlier ideas regarding the proposed new steam turbine generator. A more accurate forecast of results was to be expected than in 1928, for records of power and steam consumptions were available for actual operating conditions, about which estimates had to be used in 1928.

This check confirmed the decisions made in 1928, so, accordingly, it was decided to complete the plan as originally laid out by installing a 2500-kw. steam turbine generator, bleeding at 110-lb. pressure through the existing high-pressure piping to process and heating, and exhausting at 8-lb. pressure to the coating mill and paper machines through the low-pressure piping system previously installed. Arrangements for this were made and the machine was put into service, with 375-lb. throttle pressure and 150 deg. F. superheat, in July, 1931, thereby completing the program outlined in the spring of 1928. To raise the boiler pressure from 150 to 400 lb., it was necessary to remodel the high-pressure steam piping and the feedwater system. A new high-pressure header was run to the 2500-kw. turbine and the old 150-lb. header was used for 110-lb. bleeder steam. Practically no changes were required in the low-pressure piping system beyond those incidental to the installation of a new open feedwater heater of deaerating type. The usual cross connections, with reducing valves and desuperheaters, were provided between the high and low-pressure steam piping systems. The feedwater system changes consisted of installing new feed pumps and piping and the application of sodium phosphate treatment.

Examination of the piping diagram (Fig. 9) will give a clear idea of the arrangement, and will show how the system was changed over from the original pressure to 400-lb. pressure.

The steam distribution diagram (Fig. 8) supplements the piping diagram and shows the steam flows summer and winter, averaged from the 1930 records, and the expected average flows with the new turbine and 400-lb. boiler pressure.

An interesting feature of this system is the governing and back pressure control. The turbine runs on speed governing and the variations in low pressure process steam supply and demand are coördinated by governing

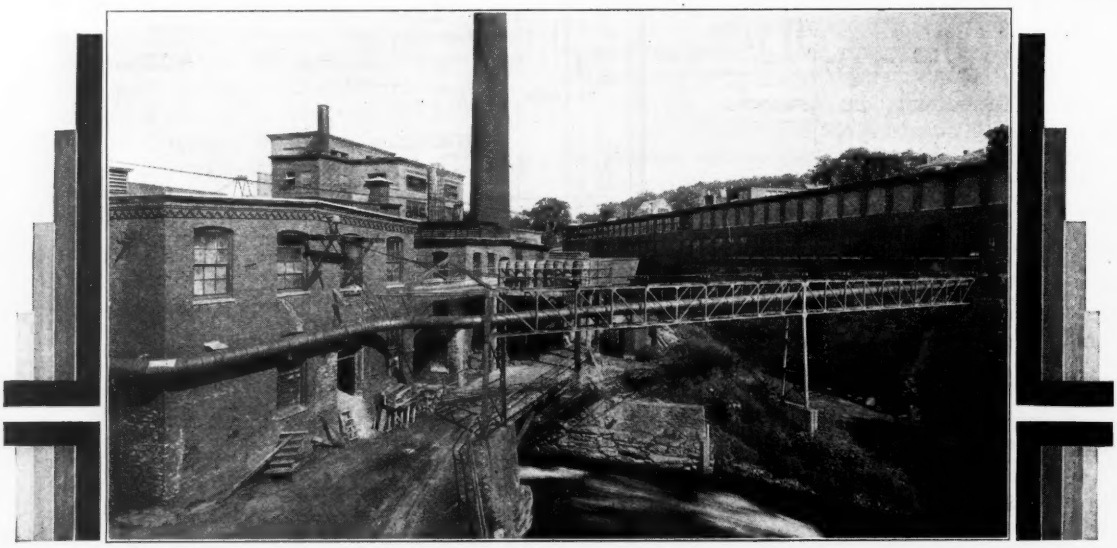


FIG. 11. FOURTEEN INCH LOW-PRESSURE STEAM LINE RUNNING FROM THE TURBINE ROOM TO THE COATING MILL

the water wheel gate opening from the pressure in the low-pressure steam system. This is the idea of the chief engineer, L. B. Rogers, and is quite novel and original, and is working out in an excellent manner. The speed control of the system from the new turbine is a noticeable improvement over that from the water wheels. A typical graph of the gate opening on the water wheel is shown in Fig. 10. The regulator which controls the gate opening is shown at the right in Fig. 7.

A general arrangement of the plant can be easily understood from inspection of the photographs and drawings reproduced herewith. A description of the boiler plant reconstruction was printed in "Power Plant Engineering," February 15, 1930, issue.

The principal equipment installed in making the development was according to the following list:

FIRST STEP—1928-1929

Equipment:

Boilers—Two 552-hp., 400-lb. pressure, cross drum, Walsh & Weidner Boiler Co.
Superheaters—Two 24 U-bend element, without cores, 400-lb. pressure, Foster Wheeler Corp.
Soot Blowers—8 elements per boiler unit, Diamond Power Specialty Co.
Water Walls—Two—76 sq. ft., in 26 armored elements for bridge wall, Foster Wheeler Corp.
Air Preheaters—Two—10,000 sq. ft. regeneration Ljungstrom, with separate fans, Air Preheater Corp.
Stokers—Two, 5-retort, 33-tuyere, table dump, American Engineering Co.
Forced Draft Fans—Two, 23,300-c.f.m. at 7.5 in., 1392-r.p.m., double inlet, full housed, turbine driven, Green Fuel Economizer Co.
Induced Draft Fans—Two, 43,000-c.f.m., 445 deg. F. at 4.75 in., 938-r.p.m., double inlet, full housed, turbine driven, Green Fuel Economizer Co.
Fan Turbines—Two for forced draft, 55-hp., 3555-r.p.m., Type D-54 General Electric driving fans through Type S-36 General Electric single reduction gear. Two for induced draft, 70-hp., 3692-r.p.m., Type D-54 General Electric driving fans through Type ATW-500 Cleveland worm gear.
Coal Handling—8 ft. by 8-ft. hopper, two roll crusher with feeder, bucket elevator, screw conveyor over suspension bunker, traveling weigh larry with Richardson scales; capacity 30 tons per hr., Stephens-Adamson Mfg. Co.
Coal Crane—Electric locomotive, 30-ft. boom, ¾-yd. clamshell bucket, 150-r.p.m. hoisting speed, Browning Crane Co.
Ash Hoppers—Sectional cast iron, refractory lined, with ratchet operated gates, Allen-Sherman-Hoff Co.
Boiler Instruments—Steam flow,—air flow boiler meters with flue gas thermometer, also multi-pointer draft gages, Bailey Meter Co.
Boiler Settings—Solid refractory, except "Bernitz" lining in furnaces alongside walls, The Frank E. Ross Co.
Piping—Champion-International Co.
Building Foundations—Spread Footing Concrete Piles, The Gow Co.
Building Superstructures—Steel frame, brick walls, concrete floors and roof, steel sash, L. E. Locke & Son.
Flue and Air Ducts—Welded plate, Merrimac Boiler Works.

SECOND STEP—1930

Equipment:

Piping—14-in. welded steel line connecting coating mill and machine room, Braman, Dow & Co.

THIRD STEP—1931

Equipment:

Superheaters—24 U-bend loops and cores added to each unit, Foster Wheeler Corp.
Feed Heater—150,000 lb. per hr.—cast iron, open type, deaerating heater and storage tank, Cochrane Corp.
Feed Pumps—Two 250-g.p.m., centrifugal pump units, one turbine driven and one motor driven. Each unit consists of one two-stage, low pressure pump, coupled to one three-stage, high pressure pump, which is in turn coupled to the driver. The low pressure pump discharges through the soda burner waste heat C.I. economizer into the suction of the high pressure pump which discharges to the boilers, Ingersoll-Rand Co.
Feed Pump Drivers—One Type D-54—146-hp. turbine and one 150-hp. slip ring motor with manual control, General Electric Co.
Feed Regulators—Two—2-in., Type E, open float, Stets Co.
Feed Treatment—Hagan Phosphate and Soda Ash, Hall Laboratories, Inc.
Coating Mill Return Pump—One steel receiving tank and motor driven Nash Jennings pump.
Turbine-Generator—One 2500-kw., Type F, 10-stage, non-condensing and bleeding steam turbine, and 3250-kv-a., .8-p.f., 3-phase, 60-cycle 600-v. generator, General Electric Co.
Generator Air Cooler—One 1110-sq. ft. fin surface Admiralty metal tube air cooler, General Electric Co.
Main Circuit Breaker—One 5000-amp., 600-v., solenoid operated generator breaker, General Electric Co.
Switchboard—One new panel for existing board, Westinghouse Electric & Mfg. Co.
Turbine Room Crane—One 15-ton, 21-ft. span, hand crane, Maris Brothers.
Turbine Foundation and Turbine Room Alterations—L. E. Locke & Son.
Electric Wiring—Champion-International Co.
Piping—The M. W. Kellogg Co.
Reducing Valve and Desuperheater—Schutte & Koerting Co.

SAVINGS ACCOMPLISHED

While it is too soon after the completion of the program to know how closely final operating performance will agree with forecasted results, the experience thus far prompts favorable conclusions concerning the expectations and particularly so since the actual investment was very close to the estimated amount, being, in fact, slightly less than that amount.

The following comparisons of principal operating costs indicate some of the savings resulting from the changes:

	Year					
	1926	1927	1928	1929	1930**	1931
Mill Products—Tons	19,700	19,600	20,400	21,000	20,200	..
Coal Burned—Tons	22,826	19,903	20,269	19,837	16,704	..
Power Plant Payroll—Men	30*	29*	28*	20	20	18
Hydro Power Water Cost	$26,379	$33,838	$39,276	$34,095	$34,358	..

*Note: Does not include men from yard gang for unloading coal.
**Note: First full year operating new boilers

This table shows primarily the results accomplished by the new boiler plant. The coal saving in dollars was in greater proportion than in tonnage, for a material reduction in cost per ton was possible through the ability of the new stokers to handle lower priced coal successfully.

The labor reported above is complete for coal and ash handling, boiler plant operation, turbine, engine and hydro plant operation, maintenance men, and all plant electricians. The chief engineer is not included.

Turbine operation is expected to reduce the cost of water about $20,000 per year.

In addition to the savings shown by records of operating costs, considerable manufacturing advantages admittedly accrue from improvements in the quality of the services furnished by the power plant.

Cooling Concrete in Hoover Dam

AFTER ANY PORTION of the concrete in the dam and tunnel plugs has set for a minimum period of six days, it will be cooled to about 72 deg. F. by running cool water pipes placed in the concrete. The refrigeration plant for removing the excess heat will have three units, interconnected so that they may be used in combination or separately.

Refrigeration capacity will be sufficient to reduce the temperature of a flow of 2100 gal. of water per min. from 40 deg. to 47 deg., the average temperature rise of concrete above placing temperature due to setting. Heat to be removed is approximately 700 B.t.u. per deg. per cu.yd. of concrete. In the month of July with a mean monthly temperature of 93.8 deg., the maximum temperature of the concrete will be 133.8 deg.

It is estimated that cooling water must be applied for 2.3 months to reduce the temperature of the concrete to 71.7 deg., the average of the mean monthly temperature for the year. It is contemplated that 2-in. standard pipe and fittings, or boiler tubing, will be used and that there will be required the installation of about 800,000 linear feet or 150 mi. of pipe, in lines 10 ft. apart.

EXCESSIVE ASH in coal is undesirable because it costs money, increases maintenance, lowers efficiency and costs as much for freight as carbon; nevertheless a certain amount is necessary to keep the grates cool.

Cobble Mountain Power Development

IN CONNECTION WITH THE NEW COBBLE MOUNTAIN RESERVOIR, CITY OF SPRINGFIELD, MASS., INSTALLS HYDROELECTRIC PLANT OF 33,000 KW. CAPACITY

PRINCIPAL FEATURES of the new Cobble Mountain reservoir and power development of the Springfield Water Works, City of Springfield, Mass., are shown in the accompanying illustrations. The development, as a whole, includes the Cobble Mountain reservoir to impound the water of the Little River by means of the world's highest earth dam, the Cobble Mountain tunnel leading from the reservoir to a power house farther down on the river and an intake tunnel downstream from the power house for conducting the water to a large filter plant.

The Cobble Mountain reservoir itself covers an area of 1031 acres with a total possible storage capacity of 22,237,000,000 gal. Besides this reservoir, another smaller one, the Borden Brook reservoir, has a capacity of 2½ billion gallons.

The dam, 245 ft. high, has a hydraulic core with shoulders of sand, gravel, rock and boulders, the base of the dam being of rock fill and the upstream and downstream toes of the dam also of rock fill. Total width of the dam at the base is over 1500 ft.

SPILLWAY AND TUNNEL

As shown in Fig. 1, a spillway is provided, emptying into Little River. The tunnel is about 7100 ft. long with an open cut leading from Stow Brook to its entrance and a shaft approximately 20 ft. square located 220 ft. from the entrance. The area of the tunnel approaching the shaft is 100 sq. ft. and the outer shaft is 79 sq. ft. The entire tunnel is lined with concrete having a minimum thickness of 7 in. In the shaft a 12-ft. by 14-ft. Philips & Davies Broome gate is installed with its sill 122 ft. below the top of the flash boards. Racks in front of the gate extend from the gate sill elevation to above high water level. The gate is operated by an electric hoist in a house over the top of the shaft.

Outlet end of the tunnel has a steel lining 10 ft. in diameter, 450 ft. long inside the concrete lining. Immediately outside the tunnel outlet and on the tunnel center line is a surge tank 25 ft. in diameter and 207 ft. high. The tunnel lining passes through the foundation of the surge tank and a 5-ft. 7-in. outlet from the 10-ft. lining extends up to connect with the bottom of the surge tank. This tank has no internal riser.

WATER CONTROL VALVES

Just beyond the surge tank foundation, the tunnel lining connects to a manifold having three outlets, the center one 5 ft. and the side outlets 7 ft. in diameter. This manifold is the Larner Engineering Co.'s patented design of plate steel construction with heavy steel castings around the crotches, all tied together with heavy stay bolts. To the outlets of the manifold are connected Newport News Shipbuilding & Dry Dock Co.'s butterfly valves, which are motor operated with the motors in a small building over the valves and controlled from the station switchboard.

These butterfly valves were designed for operation under normal head of 220 ft. The leakage guarantee is not more than 0.1 c.f.s. for the 7-ft. and 0.075 c.f.s. for the 5-ft. valve. At the station end of these penstocks, Newport News butterfly valves, two 6-ft. and one 4-ft. 3-in., are placed. These valves are designed for maximum working head of 580 ft. Leakage guarantee for these valves was 0.13 c.f.s. for the 6-ft. and 0.09 c.f.s. for the 4-ft. 3-in. valves under 215 lb. pressure. These lower valves are operated by hydraulic cylinders designed to close the valves in two minutes. A bypass is

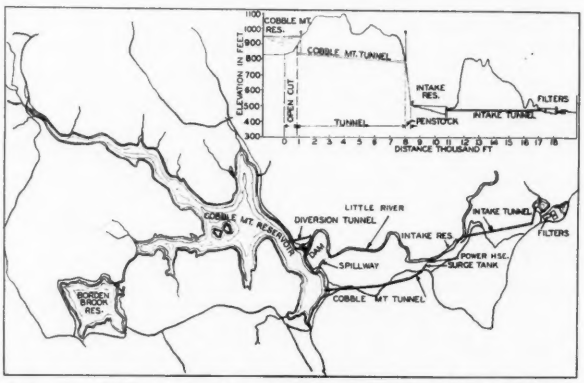


FIG. 1. GENERAL PLAN AND PROFILE OF COBBLE MOUNTAIN DEVELOPMENT

provided for each of these lower valves but was not considered necessary for the upper ones.

Two penstocks 7 ft. 9 in. in diameter and one 5 ft. 6 in. in diameter, about 660 ft. long and dropping in elevation 284 ft., run between the two sets of butterfly valves. Just below the upper valves and at the upper end of the stocks, a Coffin air valve and a manhole are provided for each penstock. The penstocks, manifold, and tunnel lining were furnished by Walsh Holyoke Steam Boiler Works, the surge tank by Chicago Bridge Co.

WATER WHEELS AND GENERATORS

In the power house three water wheel generating units are installed. The turbines, of single runner, Francis, vertical shaft, right-hand volute casing type were designed by the manufacturer, I. P. Morris & DeLaVergne, Inc., to develop 13,650 hp. each on the larger units and 5750 hp. on the smaller unit. The larger turbines are designed for this output when operating at 450 r.p.m. under effective head of 330 ft. They are guaranteed for best efficiency at 420 ft. effective head when they will develop 19,200 hp. each. Maximum guaranteed efficiency at this head is 90 per cent, while at heads of 330 and 450 ft. the maximum guaranteed efficiency is 89.5 per cent. At 450-ft. head, the maximum guaranteed power is 20,500 hp. each. These two larger turbine have steel cases and runners.

The small turbine placed in the station between the two larger ones is designed to develop 5750 hp. at 600 r.p.m. and 330 ft. effective head with its best efficiency of 89 per cent guaranteed when operating at 420 ft. head. At 330 and 450 ft. head, maximum efficiency will be 88 per cent and 88.5 per cent respectively. Maximum power at 420 ft. and 450 ft. will be 8550 and 9350 hp. respectively. This smaller turbine will have a cast-iron case and bronze runner. All three turbines have babbited oil steady bearings and Moody spreading draft tubes. On the larger turbines, Morris Pelton No. 4 actuated oil pressure governors are used while a Woodward actuator type oil pressure governor controls the smaller unit.

The two large generators are Westinghouse 13,620-kv-a., 70-per cent power factor, 6900-v. vertical units complete with 250-v. direct-connected exciter and Kingsbury oil thrust bearings. The small generator is a 5760-kv-a., 70-per cent power factor, 6900-v. vertical unit with exciter and Kingsbury bearing.

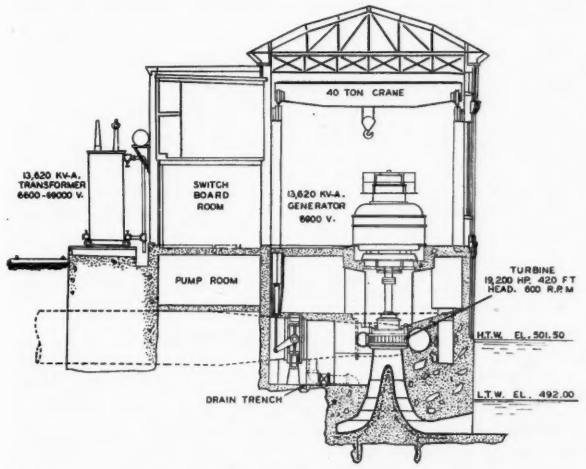


FIG. 2. CROSS SECTION OF ONE OF THE 13,650-HP. UNITS AT COBBLE MOUNTAIN POWER HOUSE

Two General Electric 3-phase forced oil-cooled 13,620-kv-a. and one 5760-kv-a. transformers are arranged on the uphill side of the station. The low voltage is 6600-v. delta, with high voltage taps for 70,725/69,000/67,275-v. connected to ratio adjuster.

Oil circuit breakers consist of five General Electric 600-amp., 73,000-v., T.P.S.T. type F.K.D.-139, nonautomatic motor-operated units, three between transformers and outdoor bus and the other two between the bus and the outgoing line. There will be no low tension bus. Three 150-kv-a. transformers tied to the bus with fuses provide house service. Figure 2 shows the general arrangement of the power house and its equipment.

Operation of the Station

Concerning operation of this Cobble Mountain project, the engineers state that records covering the past 24 yr. show that the average annual runoff from this drainage area is 94 c.f.s. The present average draft of water by the City of Springfield is 18 m.g.d. or 28 c.f.s. which will pass through the small wheel daily, leaving a balance of 66 c.f.s. which may be accumulated in the reservoir for power use as desired. If this 66 c.f.s. surplus runoff is concentrated into 13 weeks' use each year, that amount together with the daily city draft of 28 c.f.s. will furnish 288 c.f.s. for the 13 weeks' period. If the 228 c.f.s. is again concentrated into a 44-hr. per week use, that is 8 hr. a day for 5½ days, it will furnish 1100 c.f.s. or sufficient to operate the station to capacity on a 44-hr. per week schedule for 13 weeks each year. During the low water period each year, it is necessary, of course, to carry the peak of the system load on the hydroelectric station of the system and to supply the base of the load by steam.

Thirteen weeks' use of this station per year on an average is sufficient to reduce the amount of steam capacity required on the system by approximately the capacity of the station at minimum head. It becomes equivalent, therefore, to a standby steam plant with its coal pile stored behind the dam ready for use when penstock valve is opened. Taking all factors into consideration, together with evaporation and leakage, careful studies by the engineers indicate that the capacity of the station will supplant steam capacity of at least 23,000 kw. under the worst possible combination of circumstances, this being the capacity of the station at minimum head.

The Cobble Mountain water supply and power development has been carried out by the Springfield Water Works, of which Elbert E. Lochridge is chief engineer. The consulting engineer was the firm of Hazen & Whipple.

Welding for Plant Repairs

WELDING in power plant repairs is continuously proving a saver of time and expense. In a steam turbine vacuum pump, the bronze diffuser ring was faced on the side with 42 blades, tapered from ¾ in. at the outer end to a chisel edge at the inner end. Erosion soon wore away some blades at the thin end, making necessary replacement, which was expensive. It was found practicable without preheating to build up the worn blades with bronze welding rod and shape them smooth with a hand file.

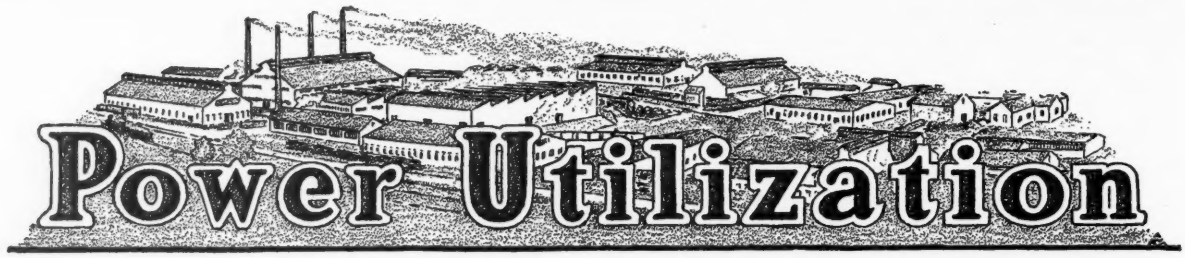
In an eastern plant, the coal distributing plows in the pulverizing mill wore rapidly. By facing the wearing edges with a 1/16-in. coating of Haynes Stellite, welded on, life of the plows was increased several fold and, when they became worn, a new facing put them in shape for service again.

In a pulverizing mill, the surface of the large ring against which the rollers revolved became worn to depressions and corrugations after a short period. Hard facing this ring prolonged the service period effectually.

Blades of blower fans in the pulverizing mill were also coated with bands of Stellite and piping bends were Stellited on the inner surfaces where wear is greatest by splitting the pipe into halves, applying the hard surface and welding the halves together.

For a transmission line, where metal street poles corroded at the joint to the base, the corroded portion was easily built up by oxwelding, at a saving of some $100 for each pole over the cost of replacement.

THE EFFECT of viscosity on centrifugal pumps is to lower the head capacity course and increase the power consumption.



Economical Small Plant Refrigeration

BRINE SPRAY SYSTEM WITH WELDED PIPING IN AMMONIA LINES IS EASILY BUILT AND OPERATED.

BY J. F. STALEY

REFRIGERATION in a small plant calls for simple equipment in order that overhead may not be excessive yet must be effective and economical if it is to do the job properly.

With present keen competition, the small slaughter house or butcher shop must have cold storage to keep its product in good condition and prevent loss, yet should not be burdened with an expensive plant. Illustrations herewith show the arrangement installed in one such plant, that is giving satisfactory results.

PLANT ARRANGEMENT

It consists of a 5½ by 5½-in. single-acting, ammonia compressor, A, running at 160 r.p.m. driven by a 10-hp. motor which runs 1200 r.p.m. This is automatically controlled to hold temperature steady, the same control handling also the pump, F, that circulates water through the shell and tube ammonia condenser, D. This condenser, 10 in. diam. by 18 ft. long has a cooling tower system for the water, about 5 per cent make-up being supplied through a float valve which feeds a pan beneath the ¼-in. cooling sprays. The circulating piping is 2-in. in diameter and motor driving the pump is 2 hp. Directly below the condenser is the ammonia receiver, E, from which liquid is taken through a ½-in. line *c* to the coils, J, in the brine tank.

This tank is of 3/16 in. steel plate, 14 ft. 6 in. by 3 ft. 6 in. and 3 ft. 8 in. deep. Its cover of 2-in. white maple plank is supported on 2-in. by ¼-in. tee irons and serves as a hog cutting table. It is set to allow an air space between tank and cover. Expansion coils are of 1¼-in. pipe, 14 ft. long by 10 pipes high, 3½ in. between centers of pipes. Nine coils are used, spaced 3½ in. centers across the tank.

AMMONIA SYSTEM WELDED

To make these coils, pipe was bought in random lengths with plain ends, bends cut off and formed by cutting, bending to a miter and welding, using a piece of boiler tube to slip over the pipe when welding so that all bends were exactly alike. Bends were then welded to proper lengths of pipe and the ends of coils welded into 2-in. headers, the bottom one for connecting to the liquor line and the top one for the suction line

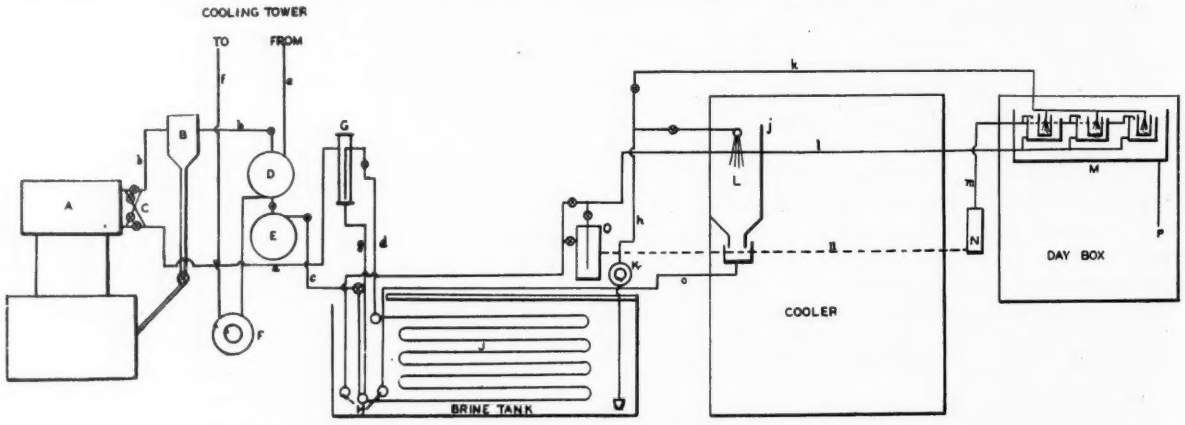


FIG. 1. DIAGRAM OF PLANT ARRANGEMENT AND CONNECTIONS

A, Compressor 5½ by 5½ in. 10-hp. motor. B, Oil separator, drains to crank case. C, Cross-over connections for pump out. D, Ammonia shell and tube condenser. E, Ammonia liquid receiver. F, Cooling water pump, 2-hp. motor. G, 4-in. ammonia gas accumulator and separator. H, Brine return lines headers. J, Expansion coils in brine tank. K, Brine circulating pump, 2-hp. motor. L, Brine Spray system in main cooler. M, Brine sprays in day box. N, Brine overflow barrel. O, Can for strengthening brine. *a*, 1¼-in. ammonia suction gas line. *b*, 1¼-in. ammonia gas line to condenser. *c*, ½-in. liquor line to expansion coils. *d*, 1¼-in. ammonia line to accumulator. *e*, 2-in. water line from cooling tower. *f*, 2-in. water line to cooling tower. *g*, ¾-in. drain line from accumulator. *h*, 2-in. brine supply line. *j*, 2-in. brine header in main cooler. *k*, ¾-in. brine line to day box. *l*, 1-in. brine return from day box. *m*, 2-in. brine overflow from day box. *n*, 2-in. brine return from barrel. *o*, 2-in. brine return from main cooler. *p*, drain from day box to drip pan.

connection. To the lower header was also welded the connection for ½-in. liquor line and a ¾-in. connection for the drain from the accumulator, G. To the upper header was welded a 1¼-in. connection *d* for ammonia gas to the accumulator. All connections were made long enough to extend above the top of the tank so that the coil was placed in the tank as a unit with no joints below brine surface to give trouble. In fact, all piping in the ammonia system was welded, the only joints being at the ammonia valve flanges. Of these there are one expansion valve, one master valve, one liquor valve for charging the system, a suction valve close to the accumulator, one suction, one discharge and two cross over valves at the compressor, a gas valve at the condenser, a ¾-in. valve between condenser and receiver and a ½-in. safety valve on the condenser. Drain from the oil trap B returns to the crank case of the compressor, so there is little chance for ammonia leakage.

Brine Sprays for Cooling

Brine spray is used for cooling the meat rooms as this is found the best method for fresh meat storage, especially for drawing heat from freshly killed animals. Better flavor and better keeping are ensured by quick chilling, which is secured by the spray system.

Brine is drawn through a foot valve in the bottom of the tank and a 2-in. suction by a 1½-in. centrifugal pump driven by a 2-hp. motor, operating continuously. In the 2-in. brine discharge line, *h*, is a mercury well for a gas-filled tube which actuates the automatic control for the ammonia compressor, starting it when brine temperature reaches 18 deg. F. and stopping when temperature has fallen to 15 deg. There is also an excess pressure control which shuts down the compressor when head pressure reaches 240 lb.

In the main cooler, which is 12 by 14 ft. with 10 ft. 6 in. ceiling height, there is no insulation on the floor, walls having 4 in. of sawdust between two layers of ⅞-in. tongued and grooved boards, with inside lining of sheet iron. Six ¼-in. sprays are used fitted into a space 18 in. wide, 12 ft. long and 5 ft. high as indicated at L. A metal pan catches the brine, which is returned through a 2-in. pipe to the brine tank. Supply to the six sprays is from a 2-in. header, *j*.

The day box for retail sales is on the floor above. It is 9 by 9 ft. with 7-ft. ceiling and is cooled by three ¼-in. sprays supplied from 2¾-in. brine line at 10 lb. pressure. Two sprays will maintain a temperature of 28 deg. even when the box is opened and closed an average of every 5 min. throughout the day.

Temperature in the main cooler never rises above 36 deg. and in 12 hr. after being freshly filled with 35 hogs weighing 200 lb. each and 8 sides of beef of 300 lb. each, the temperature will be down to 28 deg.

In the brine tank room, which is 14 ft. 6 in. by 12 ft. with 10 ft. 6 in. ceiling, cooling from the tank and piping is sufficient to hold the temperature at 36 deg. which is as low as needed.

This plant has been in operation over a year. The cost for power and water is less than for ice formerly used, which cost $3.50 a ton at the ice plant. With ice, the temperature was never under 40 deg., which left the meat soft so that the losses were high. Now the meat is firm and none lost. Labor for operation is less than for hauling and handling ice.

The compressor runs only about two-thirds the time that would be required for direct expansion in the rooms. There is no frost on the lines and, even when outside temperature is up to 90 deg., the temperatures inside are easily held with a head pressure of 145 lb. and suction of 26 to 30 lb.

Brine Spray Details

Details of the spray arrangement in the day box are shown in Fig. 2. Each spray has a control valve, the spray discharging through a 6-in. pipe into a spray pan of 10-in. pipe set in the drip pan. A screen is placed over the spray pan to reduce spatter. Bottoms of spray pans have a 1-in. drain connection to a 1¼-in.

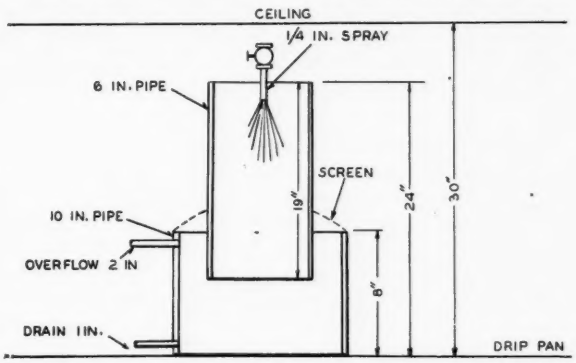


FIG. 2. DETAILS OF BRINE SPRAY ARRANGEMENT

drain line, *l*, Fig. 1, and a 2-in. overflow from near the top connects to a 2-in. drain, *m*, Fig. 1, discharging to a brine barrel, N, outside the day box. Overflow into this barrel indicates a stoppage in the drain and need for attention.

In a spray system, it is necessary to strengthen the brine each week, to 70 deg. salinometer, which is done by means of a can O, Fig. 1 set on top of the brine tank near the brine pump. This is filled with salt and return brine from the day box is passed through it until the required strength in the tank is attained. Circulation through the can is then shut off and brine returns direct to the tank. There is no valve on the brine return from the main cooler, the discharge from it, as well as from the day box being to a 2-in. header running across the tank at the end farthest from the suction foot valve.

Ammonia gas is drawn from the expansion coil header to the accumulator G, Fig. 1 through a 1¼-in. gas line. The accumulator, which also serves as a separator, is of 4-in. pipe, 28 in. high, with the inlet pipe carried to the bottom and ending in a cross. Liquid ammonia separates out and drains back through an open ¾-in. line to the expansion header. From the top of the accumulator, a 1¼-in. gas line, *a*, is carried direct to the suction of the compressor.

The Westinghouse Lamp Co. announces a new vacuum type 30-w. Mazda lamp in a G-19 bulb, available October 1, 1931. It is designed for a life of 600 hr. and will be supplied in only two voltages, 115 and 120. List price of the new lamp will be 15 cents.

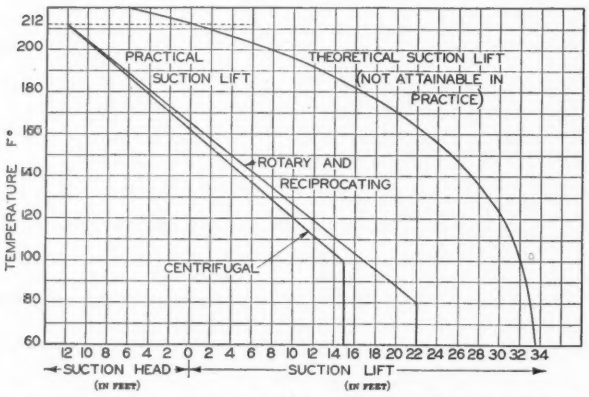
In addition to the standard inside frosted style, Westinghouse 30-w. Mazda lamps will be outside coated in five colors; namely, white, ivory, flametint, rose and red.

Pump Installation

SINCE LITTLE maintenance attention is required, there is a tendency to stick a pump away in any dark corner, the result being generally no attention until trouble appears. To get the best in performance and life of a pump, it should be looked after regularly, especially as to glands and lubrication, hence should be so located that inspection will be convenient and lack of good condition will be noticed.

Suction Lift

Aside from this, suction lift is the only limitation. For cold water, the practical limit at sea level, for reciprocating or rotary pumps is 22 ft., for centrifugal pumps is 15 ft. When hot water is to be handled, the limit is reduced as shown in Fig. 1, from Pump-Fax, a pamphlet issued by Goulds Pumps, Inc., from which also



SUCTION HEADS FOR VARIOUS INLET TEMPERATURES

much data has been taken. If operation is at an altitude above sea level, lift limits should be reduced 1 ft. for each 1000 ft. altitude.

For liquids other than water, the lift for water should be divided by the specific gravity, of the liquid except that, for volatile liquids, the lift must depend on the vaporizing temperature.

From the lift given must be subtracted the friction head in piping, strainer, foot valve and suction valves, also the velocity head for liquid entering the pump. The method for determining these heads is given in the issue of Feb. 15, 1931, page 273.

Foundation

For small and slow speed pumps, bolting to a good plank floor is often sufficient but, for larger sizes and high speeds, a substantial, well-leveled foundation should be provided to prevent vibration, insure alinement and to carry the outboard bearing where one is needed.

While a heavy bedplate is provided, this will not ensure alinement, if placed on an uneven foundation. The pump should be placed in position, allowing ¾ in. for grouting, leveled with wedges, making sure that it works freely and that couplings on a direct-connected unit are in line. Then build a grouting dam around the foundation to the height of the outer edge of the bed plate and grout in place with a thin mixture of Portland cement and water. After the grouting has hardened to stiffness, the part outside the bed plate may be removed, the rest being allowed to set at least 24 hr. before bolting down the pump. Wedges may well be left in place.

After bolting down, check again for leveling, free running and for coupling alinement. If the pump is steam-turbine driven, lining, leveling and checking should be done with the turbine hot, otherwise expansion may throw out the alinement.

With everything ready, turn the pump over by hand to make sure that all is clear. Before starting a centrifugal pump under power, the casing should be filled with liquid or "primed," as sealing glands are cooled by the liquid and may be injured if run dry.

Piping

Piping should be connected only after the pump is completely installed and leveled. It should be self supporting, so that no strain will be taken by the pump casing, hence it is well to check freedom of operation after piping is connected to be sure that there is no binding or misalinement.

Suction pipe should be at least as large as the connection to the pump, should be short and straight as possible with no unnecessary fittings. Air leaks must be avoided, especially with centrifugal pumps and air pockets prevented by the sloping the line upward from foot valve to pump at least 1 in. to each 15 ft. of length.

Loss of head in the suction may be reduced by using larger pipe, with an eccentric reducer to make connection to the pump, the "high side" of the reducer being placed at the bottom.

At the inlet to the suction line should be a strainer with openings such as to stop any material that would get stuck in pump or piping but with total area of openings some 50 per cent more than the pipe cross-sectional area. If a foot valve is used, this too should have 50 per cent excess area.

For high lift, suction head or a long suction line, a vacuum chamber steadies flow of the liquid. This should have a volume twice the pump displacement and should be connected either opposite to the suction inlet or on a tee in the suction line as close as possible to the pump.

For the discharge line, short, straight and free as possible of fittings is also the rule but sufficient valves should be used to control delivery as desired. Slope should be to drains so placed as to empty the piping in freezing weather. Near the pump a gate valve is needed to shut off back flow from the line when inspecting or repairing. For centrifugals this may be used also to regulate flow but not for a reciprocating or rotary pump, as closing it part way will only increase pressure unduly in the pump itself. A check valve near the pump will cut off back surges in case of water hammer in the line and a relief valve between the pump and stop valve may save a cracked pump casting in case a reciprocating pump is started with the stop valve closed. Such a valve set to open at somewhat above normal working pressure may discharge back to the suction line without loss of liquid. It should, however, be tested at least weekly to ensure that it will be in condition to operate when occasion arises. For a motor-driven reciprocating pump, a bypass valve from discharge to suction can be used to reduce starting load

on the motor. For a centrifugal pump, this is unnecessary as closing the main discharge stop valve will reduce load 25 per cent or more.

Irregular flow and excessive surge pressures will be alleviated by an air chamber close to the pump, of volume 3 to 6 times the pump displacement. It should have a small neck and provision for keeping it charged at least 1/3 full of air, either by draining out all liquid at intervals or by forcing in air under pressure. To avoid loss of air, connection or drain valve should be near the bottom of the chamber.

Size of the discharge pipe should be such as to make the least total expense for overhead on installation cost plus cost of power for pumping. In one case, with discharge line 1000 ft. long, at 12 per cent yearly on cost to cover depreciation, interest and repairs and with power at 2 cents a kw-hr. and 70 per cent motor efficiency, total cost using 2-in. pipe would be $674 a year; using 3-in. pipe, $260; using 4-in. pipe, $295.

Larger pipe may reduce friction and velocity head enough so that a lighter and less costly pump may be used. In the case above, friction head for 2-in. pipe would be 358 ft., for 3-in. pipe 49.6 ft., for 4-in. pipe 12.2 ft. Reduction of $240 in pump and motor cost by using a lighter pump with the 4-in. pipe would make that the most economical installation, assuming yearly overhead of 15 per cent on pump and motor.

Drainage for pump and pipe lines should be provided to take care of leakage through glands and to empty the system in case of freezing weather. Drain valves should be readily accessible and drainage points so located that no liquid pockets will be left. Leakage drains should preferably have visible discharge so that abnormal leakage will be noticed and remedied.

Machine Obsolescence

WHILE MERE AGE is not always proof that a machine is inferior to present day models, it is wise to consider that natural progress and improvement have always played an important part in the success of American industries. Obviously, logical procedure would be to determine all the factors that enter into the valuation of any particular machine.

It is with this thought in mind that the Union Special Machine Co., 400 No. Franklin St., Chicago makes public the system that is used in its factory, believing that the same method can be applied advantageously in other plants. By this system each individual machine or each individual group of machines is provided with a complete pedigree which coördinates all of the factors having a bearing on determination of the degree to which obsolescence exists.

Benefits derived from the prescribed procedure in actual operation are as follows:

1. The time for taking inventories is reduced and, in fact, machine operation may be uninterrupted during these periods.

2. Attention is constantly directed towards each individual machine, so that wasteful and inefficient units are quickly detected and the evidence of faulty performance put in a form suitable for presentation to those in authority.

3. By this method of directing attention to the mechanical equipment, officials of the operating department are automatically forced to keep in touch with all new developments and improvements in methods.

4. Ordering of replacements and repairs is facilitated, and minimum time is wasted by machines idle during operating time.

5. Financial operations of the company are safeguarded by maintaining a balance of appropriations for new equipment and avoiding unexpected expenditures.

In the system, the chief essential is a Machine Equipment Record Card of a form copyrighted by the Company, which card provides for the listing of the name of the manufacturer of the machine, also the serial numbers of duplicate machines where a group is involved. Following is an itemized list of the factors that should be considered, arranged to facilitate recording the results of periodic surveys. These are as follows: Date of Survey; General Condition of machine (Good, Fair, or Poor); Date of Purchase; Purchase Cost; Per cent of Production the machine is capable of maintaining as compared with the latest type of equipment; Quality of Work (Excellent, Good, or Fair); Type Designation of the newest machine. In detail the condition of the machine is classified as follows: Whether it must be changed and the estimated cost of change; whether it must be repaired and the estimated cost of repair; whether it must be overhauled, cost of overhauling and the date recommended for overhauling.

On the basis of the above information the machine is then allotted to one of four classifications, of which Class A denotes machine equipment which for adequate reasons should be replaced with a better machine, Class B the same as A except that the urgency for replacement is less; Class C covers equipment where specific recommendations should be made after Class A and B machines have been replaced, and Class D denotes that the equipment now in use is found to be the best obtainable for its particular function. By the law of engineering progress, the class letter of a machine will ordinarily bear a definite relation to the actual age of the machine.

Details of replacement cost are itemized in compact form under the heads of Cost of Improved Machine, Resale or Trade-in Value of old Machine, Cost of Change-over, Cost of Repairs, Cost of Overhauling, and The Net Cost of the Improved machine. Computation of the actual cost of a new machine should allow for the resale value of the old machine plus the cost of reconditioning the old machine so that it would continue to operate.

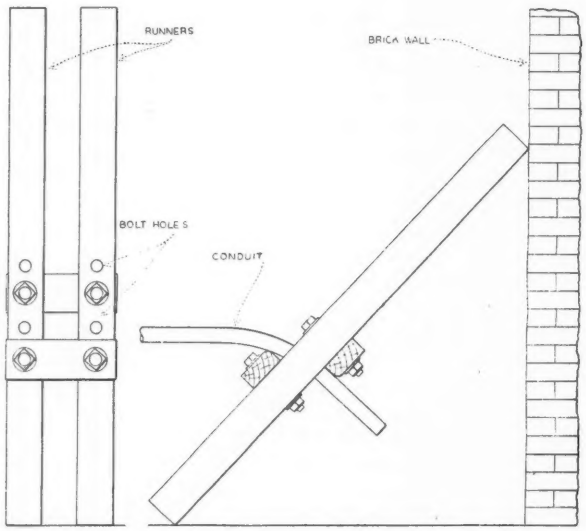
To complete the information required in determining what recommendations will be made, it is necessary to sum up the economies that can be effected with the improved type of equipment. This lists the number of new machines required, the increase in production made possible, the saving in floor space, saving in maintenance and the saving in operating labor costs. The conclusion that can be drawn from a comparison of cost and savings is so self-evident as to enable anyone to render an intelligent and justifiable decision on any question of this type.

Arrangements have been made whereby any manufacturer can obtain a supply of these record cards at cost by addressing the Union Special Machine Co.

THERE IS SOME SAVING in radiation losses with air-cooled walls but their true economy lies in the preservation of the refractories and reduced furnace maintenance

Apparatus for Bending Electrical Conduits

STEEL PIPE intended for use in the making of conduits for electric wires is much lighter than the standard grade of pipe for service under pressure, hence



SHOWING CONSTRUCTION AND USE OF CONDUIT-BENDING RIG

it is more likely to lose its circular contour under a bending strain. With suitable equipment, however, and a little practice in using the equipment, curves can be bent in unheated lengths of such pipe without appreciable distortion of the cross section.

To secure a symmetrical bend in a section of conduit it is unnecessary to pack the pipe with sand and heat it redhot. This is wrong under any circumstances, as heating the pipe will be likely to cause the insulating enamel inside to scale off and protection against corrosion will thus be destroyed. And the sand packed in the heated conduit will be sure to leave some grains embedded in the broken enamel, with consequent abrading action on the insulation of the electric wires. Rusting of the conduit will then be but a brief preliminary to grounding of the wires running through, and such grounding may occur in places extremely difficult of access.

A rig with which a nice bend can be made in a conduit of 3-inch size or less is shown in the accompanying sketch. The drawing at the left shows the device to consist of two wooden runners, each six inches square, with wooden crosspieces bolted on back and front. The rows of boltholes in the runners provide for shifting the crosspieces in accordance with the size of conduit to be inserted and the radius of bend desired. The drawing at the right shows the apparatus in position for use.

The bend should be made a little at a time, taking short bites. Trying to make the bend at one stroke will result in kinking the pipe rather than curving it. The bending should never be attempted over a hard, sharp corner. The blunt edge of a wood block is the thing for a bending fulcrum.

St. Louis, Mo. D. J. ALTIZER.

Sand Blast for Boiler Tubes

IN THE Sept. 1 issue, James E. Noble criticizes the use of a sand blast for cleaning tubes. In a way, he is right, as a sand blast in the hands of irresponsible parties, can wreck things about as badly as giant powder but with a few precautions, it can be used in a great variety of places with excellent results.

First of all, the grade of sand is an all important factor. The best sand (Red Wing, Minn.) that I have ever seen for the purpose, is one shipped all over the country for use in filters; it is a golden brown in color, with small particles of uniform size, so much so, that under a glass, they look as though they might have been sorted; the edges are uniformly sharp, but the cubic section gives it a uniform abrasive effect when the pressure is regulated to the work in hand. Glass sand from the St. Peter's sandstone is available in many localities and, while resembling granulated sugar, is the least reliable of many tried, being inferior to the common or garden variety of river sand.

Different sand blast outfits require different pressures, but as a rule, too much pressure is used. A good plan is to reduce the pressure gradually until the required results are obtained and the sand, which of course must be bone-dry before using, can be used over again for finer work. Here again, the good judgment of the operator is a vital factor. With 30 lb. pressure and graded sand, it is possible to remove 0.001 in. of mild steel in ten seconds at a distance of three feet, if the stream impinges at a right angle. On the other hand,

the same stream, directed at an angle of 5 or 10 deg., as it would be in a boiler tube, can be used for removing paint from woodwork without disturbing the filler coat.

If Mr. Leach polished the surface of his tubes, he must have used rotten stone instead of an abrasive but I think that he meant the steel showed a bright surface, not polished. Still, I fail to see why a polished surface would not be advisable with a soft coal containing sulphur; soot will not adhere so readily to a polished surface as to a rough one, and as for sulphur, if any one can combine sulphur, either free or as sulphur dioxide, with iron at anything less than a white heat, I would like to know the method and chemical formula.

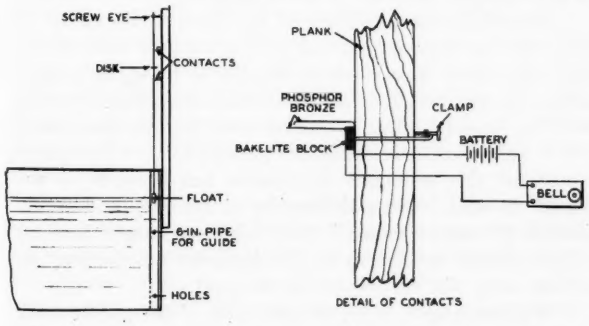
The frequency with which the blast is needed, depends on the particular coal used. Some high grade from the Trinidad (Colo.) field used to fill a tube solid in four hours, while some of the lower grade coals from the Central Illinois fields (Christian Co.) deposited so little soot and fly ash, that a daily blowing and a monthly scraping left the tubes in excellent condition.

Since I have been familiar with sandblasting, I have not had any practical experience with tubular boilers; but if I had one in charge, I would sandblast it daily for a month and keep an accurate gage of the internal diameter. If necessary, use a section of boiler tube small enough to slip into one of the regular tubes and when filled, put it on a bench and apply a blast, noting results. In the hands of a careless man, the tube could be worn through in a few minutes and this is the greatest drawback to the method.

Cleveland, O. L. R. BAKER.

Alarm for Maintaining Water Level

RECENTLY, in our dye house some of the chemists were doing some experimental work where a steady flow under almost constant head was desired. After experimenting for some time with the water taken directly from the service water lines, it was decided to make use of a large overhead tank about 100 ft. away in another building. It was a comparatively easy matter to maintain a constant level in this tank by manipulating a valve. In this way, the flow was kept constant but the arrangement meant that another man had to be stationed at the tank all the time. The level had to be changed frequently. The added expense of this man's time was frowned upon and for a while we tried a float valve so mounted that it could be moved up or down as desired. This worked well when properly placed and adjusted but took considerable adjusting every time it was changed and seemed a trifle beyond the ability of the chemist in a mechanical way so that instead of saving a laborer's time it was actually taking most of the time of a machinist.



ARRANGEMENT AND DETAILS OF FLOAT AND CONTACTS

Finally, we solved the problem to the satisfaction of everyone by making an adjustable alarm and changing the supply line to the tank so that it ran through the dye house and placed a valve there so that the chemist could control the flow from his station. Two alarm circuits were used, a high water bell alarm and a low water buzzer. These were the usual little 6-v. affairs such as used in houses and were operated by batteries. The float and contacts were as shown in the sketch. The float was a block of wood soaked in paraffin and the guide was a piece of 6-in. pipe. The upright attached to the top of the float was a thin, light piece of wood guided at the upper end through a small screw eye. The contacts were made from small strips of phosphor bronze as shown in the sketch. When the float went up, the disk on the rod would close the upper contact and ring the bell until the water level dropped. In the same way the buzzer would ring with low water until the condition was corrected. The contacts were strong enough so that the low one would support the float if the water went too low and the high one would keep the float submerged with abnormally high water.

These contacts were adjustable along the side of an upright plank and were held on by clamps. Between tests, the contacts were changed to the desired level and then the flow to the tank was controlled by the valve according to the bell or buzzer signals. It worked out fine except that it was hard on the batteries because it was ringing one way or another most of the time, but the expense was negligible.

Springfield, O. F. PAUL.

Firemen's Sliding Poles in Power Plants

NEARLY everybody is familiar with the sliding poles installed in up-to-date fire stations of municipal fire departments. When a fire alarm sounds, the firemen slide down these poles from the upper floors of the fire station to the street floor and save quite a few seconds of time, when every second of time is valuable.

In modern central stations and power plants, it is frequently necessary for an engineer or some other member of the operating force to get from an upper platform, or gallery, to a lower one in a hurry, due to trouble with some piece of equipment on the lower floor. If several sliding poles were installed in strategic positions, many seconds of valuable time could be saved in emergencies when every second counts. A saving of five or six seconds in getting from an upper floor to a lower floor might have considerable influence on the extent of the trouble and the cost of repairing any damage done.

Under normal conditions, sliding poles would also save considerable time and would relieve stairways and elevators of considerable down traffic. In new station designs, the stairways could be made smaller and less costly if a few of these sliding poles were included. Where space for stairways is limited, sliding poles would have an added advantage.

So, from the viewpoint of both safety and economy, the use of sliding poles in power plants has much in its favor.

Boston, Mass. IRA R. YOUNG.

Editorial Comment

Flue Gas Washed Free of Sulphur Dioxide

As cities become more densely populated, greater care must be exercised by industry to prevent pollution of the elements upon which life exists. Without doubt, the air we breathe is of greatest importance to humanity and its pollution where people live is intolerable.

While smoke streaming from the stacks of utility and industrial plants may be a welcome sign to the business interests of the country, municipal health authorities have forbidden its appearance to any appreciable extent and through the perfection of combustion methods this annoying condition has largely disappeared from power plants. No sooner, however, had the solution to the smoke problem been found than another and more difficult problem presented itself—that of sulphurous gases discharged into the atmosphere.

With the development of the mechanical stoker and pulverized coal burners, power plants have been able to burn lower grades of coal. That means coal with higher ash content, lower heat value, with ash that fuses at low temperatures and the usual accompaniment of high sulphur content. So, with economy in coal has come the growing aggravation of sulphurous chimney gases and increasing complaints from residents in the neighborhood of large power plants.

In London, at great expense, an elaborate flue gas treating plant was put into operation to solve this problem. It has been reported as successful in removing obnoxious gases to the satisfaction of the people in the neighborhood but the method seems entirely too expensive for general use in power plants. The necessity for a more practical and economical method of removing the injurious gases from those discharged to atmosphere has caused this subject to be studied at the Engineering Experiment Station at Urbana, Ill., and we report on another page of this issue some of the results obtained, the problem being to discover an inexpensive substance that would absorb the sulphurous gases.

While no practical application of manganese ions in washing water for the absorption of sulphur dioxide has been made, it bids fair to be accepted by utility companies for experimental installations.

Who Does Your Thinking?

Seasonal variations in output are met with in practically all industries and help give the maintenance man and engineer a chance to bring their machines and plants up to par. Only too often, makeshift measures must be taken to tide over an emergency and keep up production.

In fact, a man's ingenuity in emergencies of this kind often determines his value to an organization. The difference between a good and a mediocre engineer is, however, determined by his later actions. A good engineer will take immediate action to make permanent the emergency measures as soon as conditions permit. The mediocre engineer will be satisfied with the emergency measures and thus precipitate another emergency.

Both of these types of engineers have their limitations, however, because they sit back and let someone else do their thinking for them, content to keep running the machines that are entrusted to them. The real engineer, the type we can classify as excellent, looks farther. He realizes that, being in close touch with the actual operation and maintenance of these machines, he is in the best possible position to suggest changes and improvements.

Changes in design to eliminate weakness in mechanical strength; changes in layout to facilitate production; changes in arrangement to reduce labor; changes in control to give a better product; elimination of obsolete machines to cut costs.

Why was this machine not equipped with remote control? Why were roller bearings used on this machine and not on the others? Why were individual drives used in one place and line shaft in another? Why can't these two machines be replaced by a modern one that would combine the functions of both, improve the quality and uniformity of the product and cut labor costs in half?

Many times no answer can be found because the original decisions were influenced by prejudice, ignorance of equipment or because the equipment used was the most modern at the time even though hopelessly antiquated now. Sometimes good reasons dictated by local conditions can be found for some action which at first glance appears to be the result of poor judgment.

Satisfactory or not, the answers to these questions should not end the investigation. The engineer should work out his solution of the problem backed by costs and sound arguments and be prepared to advance them at the first opportunity. The man who can give definite answers when asked, who can advance suggestions when the opportunity arrives and whose judgment is good is the man who is turned to in an emergency and is the man who forges ahead apparently without effort to the bewilderment of the man who works hard every minute but is content to let someone else do his thinking.

Crystal Gazing—1931 Style

Gerard Swope, president of the General Electric Co., is quoted as saying that the utilities should look ahead and plan their work so as to be able to tell other industries a longer period in advance what their requirements will be, thus enabling manufacturers to plan their work on a more uniform basis of production. "The great questions this economic depression has brought to the fore," he said, "are stabilization of industry and stabilization of employment." He thinks a longer forecast of industrial and business development on the part of utility men will contribute to this end.

Without question the co-operation of the public utilities with other industries in the analysis of future de-

velopments and requirements would materially assist industry in general. The utilities, in the conduct of their own work, compile some of the most valuable statistics on various subjects that can be found anywhere in this country. As a matter of fact, the utilities would be forced to do this whether they wanted to or not. They must have for their own use a fairly accurate estimate, for years in advance, of the possible growth of population in various districts, the possible expansion of industries in those districts, the possibilities of changes in the set-up of these industries, estimates of possible requirements of electric and other services and so on. Each large utility group must have such information so that it can plot its course and not find that at the end of a period of years it has expended capital where there is no need for it or failed to expend capital where it will do the most good for itself and the public.

Readers of the articles recently published in Power Plant Engineering under the title of "The Power Behind New York" will find in them a splendid illustration of how this is done by one of the largest utility organizations in the country. Part II of that series, published in the July 1, 1931, issue, discussed many of the factors of system operation as affected by the load conditions. In reading that discussion it can easily be seen that a tremendous amount of statistical data and of engineering and economic analysis of the trends shown by those data are absolutely necessary in the process of planning for the future.

It would seem that a study of the methods used by the public utilities for looking into the future could well be made by every other industry in the country. It would cost money, of course but it would doubtless be worth it, just as it is worth it to the utilities themselves. We are confident, also, that if data of this type could be corrolated with some of the data used by the utilities, the whole would prove a most valuable basis for analysis of future development, with the aim of finding out where industry is going and how it can follow the best path with the greatest amount of stability. It is evident too, that, if the utilities desired to take the lead in showing other industries how they can plot a safe course by using some of the utilities' own principles and methods, they would be performing a public service of the highest order. That the utilities are qualified in the highest degree to do this is proved by their own records of accomplishment and stability during the past three or four years.

Improving Performance in Old Plants

During the last two decades, power plant design and practice, in common with nearly everything else, has undergone intensive development. New types of equipment have been developed, new practice in the preparation and use of fuels evolved, methods for obtaining heat balance have been improved, all of which contribute materially to the possible over-all efficiency of the plant.

Because of these developments many plants built in accordance with the best practice ten or more years ago, today are producing power less economically than they might with more modern equipment and principles of practice. The equipment in such plants may be in excellent condition, capable of many more years of service, yet in view of the fact that more efficient equipment is available today, it is possible that such old equipment could be replaced with new, to advantage.

Many engineers in charge of such plants realize this but hesitate to make extensive changes because of the difficulty of determining just what should be done to modernize a plant. The problem involves more than the mere replacement of old equipment with new; indeed, often it involves the use of no new equipment at all but consists entirely in rearranging or reconnecting existing apparatus to conform with modern systems of practice. In an industrial plant the problem is complicated further by the intimate relation of industrial processes to power plant operation; a change in one is almost certain to affect the other. All of these conditions make it difficult to predict just what effect certain changes or additions may have upon the overall economy of the system.

As a consequence of these conditions, engineers are likely to approach the question of improving plant performance with reluctance and even when this reluctance can be overcome, the procedure necessary to effect such improvement is not clear. At best, the problem is one involving keen engineering judgment and full knowledge as to the requirements of the particular system involved.

In view of this state of affairs, we direct particular attention to the leading article in this issue by Marcus K. Bryan which deals with this subject. Mr. Bryan describes in detail the procedure involved in rehabilitating the power generating system of a large paper mill in Lawrence, Massachusetts—that of the Champion International Co.

In this article, the author sets forth the problem which confronted the management several years ago; one of providing increased capacity while at the same time reducing unit costs. Conditions at this plant were complicated, not only by the fact that it was a combined hydroelectric and steam generating plant but also the proposed changes involved changes in the paper mill equipment. Despite the apparent complexity of the task, however, a definite program of development was evolved and the mananer in which this was done and the way it was carried out form the basis of this most interesting article.

Conditions in different plants vary. While it is unlikely that the methods of procedure followed at the Champion International plant are applicable directly to other plants, the principles involved, the method of analyzing the problem and the manner in which the work was done should be of interest and value to every engineer confronted with similar problems. There are, no doubt, many plants in this country where similar improvements could be effected and it is hoped that Mr. Bryan's article may be instrumental in provoking further interest in this phase of power plant engineering.

MOST ACCIDENTS occur directly before noon time and directly before quitting time. The reason, we conclude, is because there is a tendency to take the mind off the job before the time of quitting arrives. Don't let the clock regulate your thinking. Keep your mind on the job until you leave it.

—Accident Prevention Bureau.

Southwest Power Conference at Kansas City

49TH ANNUAL MEETING OF THE N. A. P. E. HELD SIMULTANEOUSLY WITH MEETINGS OF THE A. S. M. E., N. E. L. A. AND 9 OTHER ASSOCIATIONS TO FORM THE FIRST SOUTHWEST POWER CONFERENCE AND SHOW

DURING THE WEEK of Sept. 7 to 11 inclusive, Kansas City, Mo., was the scene of the First Southwest Power Conference, participated in by some twelve organizations in addition to the Mechanical Engineering Departments of the universities and colleges of surrounding states. These organizations included the N. A. P. E., A. S. M. E., A. I. E. E., A. S. C. E., A. S. H. & V. E., N. E. L. A., A. C. S., Engineers Club of Kansas City, National Safety Council, State Association of Municipal Utilities (Missouri, Iowa, Kansas and Nebraska), Southwestern Coal Operators Assn. and Kansas City Coal Service Institute. Activities centered about the headquarters of the various organizations in the Baltimore Hotel and Kansas City Athletic Club with technical sessions in the Missouri Theatre and Kansas City Power and Light Co.'s new building. The Southwestern Power and Mechanical Exposition with about 100 exhibitors was held during the same week in the Kansas City Convention Hall.

At the morning session held in the Kansas City Power & Light Co.'s building on Monday, Sept. 7, the conference was officially opened by Honorary Chairman Joseph E. Porter with Albert L. Maillard, Chairman of the conference, presiding. Responses to the address of welcome were made by representatives of each of the participating organizations. The afternoon was devoted to inspection trips, golf or bridge as the visiting delegates desired. In the evening, the Power Show was officially opened in the Convention Hall.

On Wednesday, delegates met in joint luncheon with the Chamber of Commerce to hear an address by Marshall E. Sampsell. In the evening, following a banquet and dance at the Kansas City Athletic Club, E. L. Manning gave a demonstration and lecture, entitled Adventures in Science. Outside of these few joint activities, the various organizations carried out their individual meetings singly or in twos and threes as common interests drew them together.

N. A. P. E.

Delegates of the N. A. P. E. registered at the Baltimore Hotel and participated in the official opening of the Southwest Power Conference and show in joint sessions in the morning and evening. The afternoon was devoted to association business centering around the directors' meeting. Following the opening of the show in the evening a concert reception and informal dance was given by the National Officers at the Baltimore Hotel.

Albert F. Thompson, chairman of the Local Convention Committee, called the first session to order on Tuesday morning and after opening remarks introduced Lieut. Governor Edward H. Winters of Missouri, who welcomed the delegates and visitors to the state. Response to Lieut. Governor Winters was made by President Chas. A. Dobson, who expressed his appreciation for the cordial welcome tendered to convention by the previous speaker and expressed hopes for a successful and progressive convention.

In the absence of Mayor Bryce B. Smith, A. B. Gossett welcomed the convention to the city. He briefly sketched the growth of the Nation from the east to the west and pointed out the vital influence of the engineer in this growth and advancement. Response to Mr. Gossett was made by Vice-President Lisle A. Pierson, who complimented the previous speaker on his constructive suggestions and thanked the various representatives for the splendid support given the Association in handling the convention, expressing the hope that the spirit of coöperation and fair play would prevail during the convention deliberations.

Lou Holland of the Kansas City Chamber of Commerce traced briefly the growth of the city from the early pioneer days to the present day with some interesting sidelights on the most important events in growth of the community. Response to Mr. Holland was made by Past National President Frederick L. Ray.

Chairman Thompson then presented President Dobson with a gavel and block for the conduct of the convention sessions. President Dobson formally opened the convention, announced the convention committees and the session adjourned for the taking of the official photograph.

Tuesday afternoon was devoted to reports of the officials and committees. On Wednesday, 244 delegates were seated and among other business the convention concurred in the recommendation of the president to eliminate the present educational system and substitute a committee of three to handle education with an appropriation of $3000, not more than half of which can be spent for compensation for services of the committee. Wednesday afternoon was devoted to inspection trips.

General business, memorial services and the annual visit of the Ladies Auxiliary occupied Thursday morning and the afternoon was devoted to presentation of flags to associations and a lecture by Albert L. Maillard.

In the election of officers held Friday, Lisle A. Pierson of Detroit was elected president and Albert F. Thompson, of Kansas City, vice president. Milwaukee was selected as the next convention city. In the National Exhibitors Association, W. H. Gaylord, Jr., was elected president, John H. Allen, vice president and Fred G. Jolley, treasurer.

A. S. M. E.

Following registration and participation in the joint activities of the conference on Monday, technical sessions of the A. S. M. E. were held in the K. C. P. & L. Co. building on Tuesday and Wednesday. In addition to the joint luncheon and banquet with the conference on Wednesday, a joint luncheon at which Captain Theo. Wymann, Jr., spoke on the Missouri River was held with the Engineers Club on Tuesday.

Simultaneous sessions on Power, Oil and Gas Power

and Aeronautics were held on Tuesday morning and on Fuels, Petroleum and Aeronautics on Wednesday morning. Both afternoons were free for inspection trips or participation in other organization meetings.

In the Power session presided over by Edwin Jowett, three papers were presented. Grover C. Meyer outlined the power requirements of flour mills and presented data on many installations. J. A. Keeth described the installation and major operating troubles that came up during 2½ yr. operation of the 1400-lb. equipment at Northeast Station. Diphenol oxide, a newcomer in the field of power and used for the first large scale commercial plant at Bremo station (see p. 486, May 1, 1931 issue of Power Plant Engineering) and its application for preheating air was covered in considerable detail by John J. Grebe. Boiler construction and industrial application recommended for this interesting chemical were illustrated by drawings. At Bremo Station, the air heater was replaced by a diphenol economizer which is later used to heat air for combustion near the burners.

Vital needs and interests of the Southeast in oil and gas power were well covered in the session presided over by J. H. Felgar. A speed characteristic for oil engines was discussed by V. L. Maleev and internal combustion engine speeds and requirements for the oil and gas industries by H. F. Shepherd. S. A. Hadley, speaking of Diesel engines as peak load units, gave a comparison of costs for Diesel and steam stations of moderate capacity with special reference to peak load service. Emphasis was placed on the installation of Diesel units in peak load plants in outlying communities rather than in main central stations.

Major James Doolittle, transcontinental record holder, presided at the Aeronautics sessions where the following papers were presented: Practical Light Aeroplane Design, Karl H. White; Aircraft Diesel Engines, H. C. Edwards; Necessary Trends in Aeroplane Design, W. B. Stout; Aviation Insurance, J. B. Guinotte; Maintenance and Overhead of Aircraft and Engines, H. L. Bredouw and Aeroplane Landing Gears, Frederick Knack.

Coal, coal mining and refractories were the subjects of the Fuels Session presided over by E. H. Tenney. L. Russell Kelce explained the methods of and improvements in mining and preparing strip coal in the Southwest where conditions differ materially from those in the Eastern coal mines. Coal as a basic fuel was discussed by H. Kreisinger and general chemical and physical properties of boiler room refractories by J. H. Kruson.

Remarkable strides made in developing this section of the country since the intensive development of petroleum were emphasized at the Petroleum session presided over by W. Stueve. Building an Empire, a film shown by George H. Baird emphasized the tremendous undertakings successfully carried through by long distance gas transportation lines. A round table discussion led by W. G. Heltzall on the economic analyses of pipe line pumping indicated the progress that has been made in pipe line engineering while an outline of recent developments in the liquefied petroleum gas industry by O. M. Setrum pointed out the actual and potential possibilities of this fuel in industry and emphasized the importance of the petroleum industry.

In general, the remaining organizations participating joined with the A. S. M. E. sessions on Tuesday and Wednesday. The N. E. L. A. meetings of the Commercial and Engineering sections met with or held simultaneous committee meetings on Wednesday and extended their program over to Thursday. The Kansas City Safety Council with Sam Ganz presiding held their main meeting Tuesday evening with W. H. Cameron and H. C. Burgess delivering the main addresses. Requirements for successful management of municipal plants were outlined by R. E. McDonnell in the main Thursday morning discussions of the State Association of Municipal Utilities. The balance of this session was devoted to a general discussion of topics of interest to the four state associations participating.

Discussion of coal mining, distribution, purchase and other commercial aspects of the coal industry formed the basis of the business sessions of the Southwestern Coal Operators Association and the Kansas City Coal Service Institute which were continued Wednesday afternoon and Thursday following the participation of these associations in the A. S. M. E. and power conference programs.

Successful consummation of plans for such a large and diversified program, coöperation of the participating organizations and above all the arrangements made for sightseeing, entertainment and inspection trips to industrial plants and central stations around the city and surrounding country, was a gigantic undertaking which was successfully carried out under the direction of the Central Committee of the Southwestern Power Conference.

RECENTLY ANNOUNCED line of vapor-proof conduit wiring fittings, it is stated, combine complete protection with ready facility for making subsequent changes and additions to the installation with the minimum of trouble and expense. The tests successfully passed by these fittings include exposure to steam-laden air for 72 hr. The standard vapor-proof fitting consists of a one-piece casting having provision for attaching guard or reflector holder. The fitting is in all cases provided with outlets, those not required being closed with threaded plugs. The guard is of the bayonet-joint type, with two locking screws to assure proper alinement. The fitting is sealed oil and gas proof by an approved glycerine-impregnated gasket resting on a machined surface. The receptable is still further protected by being silax-waxed so that it remains vapor-proof even though, as in the tests mentioned above, both the bulb and the enclosing globe are broken.

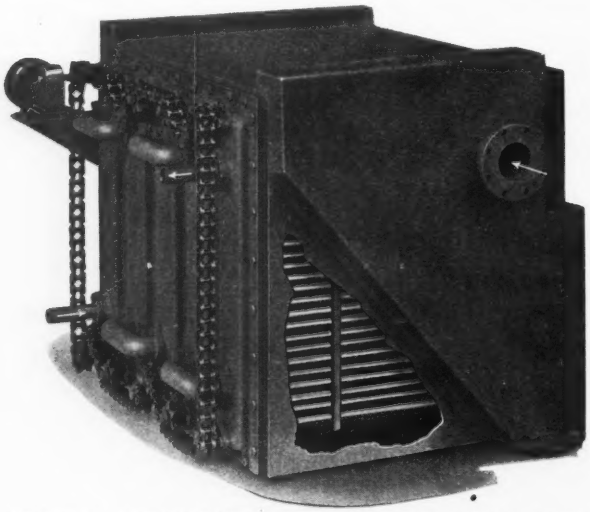
Junction boxes are the same in general design as the standard fittings except that they are so made that various types of covers may be attached for mounting 45 deg. and 90-deg. angle fixtures, receptacles, switches, etc. When the 45 and 90-deg. fixtures are used with concealed work, the use of an adapter plate is recommended as it conceals more neatly the rough edges of the concrete or plaster. These fittings are new products of Adalet Mfg. Co. of Cleveland, Ohio.

CONDENSATE or hotwell pumps used for removing condensate from surface condensers must pump against a total head made up of the vacuum in the condenser, pipe friction head and the external static head.

Power Plant Engineering Developments and News

Self-Cleaning Heat Reclaimer

SELF-CLEANING and hermetically sealed heat reclaimer for laundries or other industries having hot waste water has recently been placed on the market by the Hoppes Mfg. Co., Springfield, O. A small motor



GENERAL ARRANGEMENT OF HOPPES HEAT RECLAIMER

is provided to clean the apparatus in from 3 to 5 min. a day. This is done while the hot water is flowing and it is stated that no other water or attention are required. The apparatus is designed to shunt the cold water through without coming in contact with the heating tubes. This, together with the provision for cross counter flow, is intended to give the highest possible efficiency in heat exchange. The reclaimer is made on the unit plan in any size to suit conditions, and is arranged to be extended by adding more units when desired. The manufacturer states that they can be supplied in sizes from 1000 gal. per hr. to 60,000 gal. per hr. and that sizes larger than this can be built special.

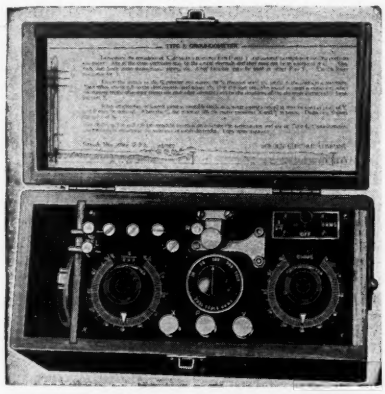
Groundometer Measures Ground Resistance Directly

IN THE INSTALLATION and operation of electrical equipment, it is essential that good "ground" connections be made. It is necessary, therefore, to have available, some means for accurately determining the ground resistance of the ground connections.

To determine this, the Groundometer shown in the accompanying illustration, has been developed. This, it is claimed by the Borden Electric Co., Newark, N. J., by whom it was developed, is the only American made meter which gives directly, without calculations, the resistance of the electrode under test.

While the Groundometer has other uses, it is designed especially for measuring the resistance to the flow of current from a metal electrode into the surrounding earth. It is designed to withstand rough usage and has no delicate parts or moving instrument elements. In many ways its construction and operation may be likened to that of the ordinary slide rule.

The Groundometer is fundamentally a Wheatstone bridge and its operation is similar to that of a "bridge."



THE GROUNDOMETER FOR MEASURING GROUND RESISTANCE

The circuit is balanced by means of a telephone receiver. It is housed in a sturdy oak case having a leather carrying handle and may be safely transported with other tools and equipment in a line construction truck. It is provided with a battery and an interrupter. The scales are direct reading, the resistance being indicated directly in ohms.

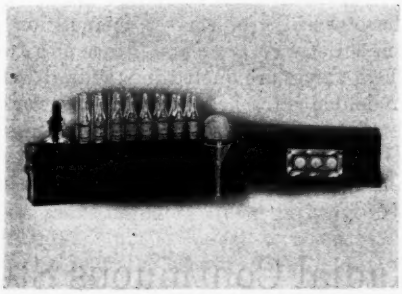
Allis-Chalmers Develops New Explosion Type Motor

ALLIS-CHALMERS MFG. CO. has developed a new line of explosion-proof motors that is approved for use in hazardous atmospheres such as are encountered in oil refineries, gasoline plants, dry cleaning plants, paint, varnish and lacquer plants, and similar installations where explosive atmospheres are encountered. These motors have been tested and approved by the Underwriters' Laboratories and carry the Laboratory

label for use in Class 1 Group D locations, gasoline (pyroxoline, lacquer vapor). The construction of this explosion-proof motor is along the general lines of the Allis-Chalmers totally enclosed, fan-cooled motor, having the same simple design, with all parts readily accessible. Its special features include extra long bearing seals to prevent the escapement of flame and to cool the gases below the point of ignition, special alloy steel cap screws that fit into tapped pockets, and unusual sturdiness to safely resist stresses due to possible internal explosions or flashes. In addition to the sealed motor leads, a special explosion-proof cast-iron conduit box gives additional protection against possible contact with surrounding air.

Test Set for pH Determinations

USEFUL AND INEXPENSIVE testing sets have been developed by the York Ice Machinery Corp., York, Pa., for the particular use of the ice making and refrigerating engineer so as to enable him quickly to determine the pH value of his brine solution. This set will serve a definite purpose in the power plant, also,



THE YORK ICE MACHINERY CORP. BRINE TEST SET

for testing boiler feedwater or any water solution of neutral salts. Essential parts of the Yorkco Brine Testing Set are the standards which contain liquids of known chemical condition; a means of comparing their colors with that of the sample, after the proper amount of indicator has been added; and a supply of a suitable indicator.

Values of the exact chemical condition of the standards are apparent to the eye because of the various colors associated with each unit of acidity, alkalinity or neutrality. In addition to the 13 color standards and indicator are included three test tubes, glass funnel and filter paper. The life of boiler and condenser tubes can be greatly prolonged by controlling the chemical condition of the water.

High Cycle Portable Electric Tool Motors

IDEAL PORTABLE ELECTRIC tools are those which combine light weight with great power, low maintenance cost and little time-out for repairs. This, to the portable electric tool manufacturer, is a big order, inasmuch as up until 5 yr. ago nothing had been developed in the electric motor field which would enable the fabrication of such an ideal unit as mentioned at the beginning of this article. The universal electric motor, with its unlimited speed characteristic, represented the best available motor unit for portable electric tools; however, experimental work with induction type alternating current motors led to the development of the squirrel cage welded rotor motor.

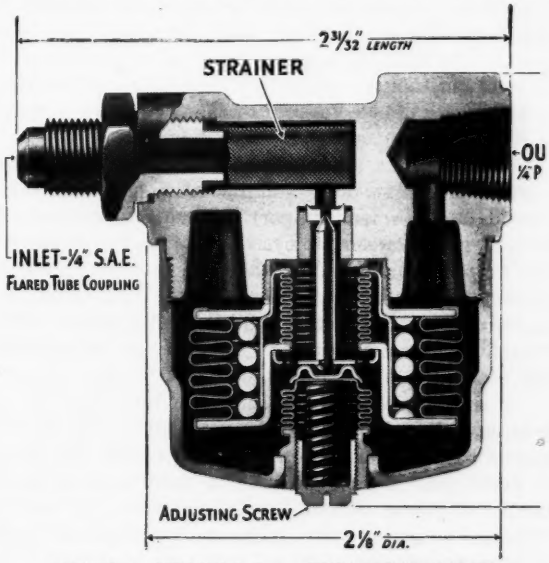
This squirrel cage type of motor, having the advantages of no revolving wires, no sliding contacts or complicated brush rigging, lent itself ideally to the portable electric tool application. Its only limitation was the fact that the comparatively slow speed of 3600 r.p.m. was the maximum obtainable from 60-cycle alternating current.

This 3600-r.p.m. speed was not sufficient, inasmuch as light weight with power could not be obtained; hence, the idea was conceived by the Black & Decker Mfg. Co., Towson, Md., of using alternating current of high frequency, in order to produce a greater motor speed, thereby enabling that manufacturer to obtain greater power on the work end of the tool by gearing down the high speed obtainable from high frequency current.

One hundred eighty (180)-cycle alternating current has been determined upon by the portable electric tool manufacturers as the necessary current for operating high cycle tools, inasmuch as motor speed of 10,800 r.p.m. is obtainable with this current. This motor speed nearly approaches the speed of Universal current electric motors as used in portable electric tools and the high cycle tools possess the added advantage of the a.c. induction type motor, in that it is the nature of this motor not to slow down under load; as a matter of fact, the maximum deceleration under load does not exceed 10 per cent.

Automatic Expansion Valve for Refrigerating Systems

FOR USE ON VARIOUS kinds of refrigerating systems, a new automatic expansion valve has been placed on the market by Gustave Lidseen, Inc., 832 S. Central Ave., Chicago, Ill. This valve, it is claimed,



SECTION THROUGH G. L. EXPANSION VALVE

is fool proof and its simplicity of construction results in low maintenance costs. It may be used with sulphur dioxide, methyl chloride, or any refrigerant not detrimental to brass or copper.

The special features of this valve are 1. It is direct acting. The adjusting screw is directly in line with the needle valve which is not disturbed by other intermediate parts in its action.

2. The needle is self centering, which prevents the valve seat from wearing oval.

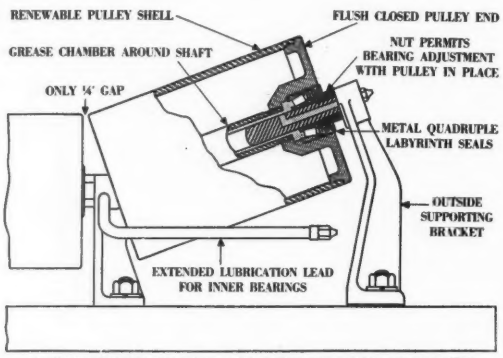
3. The valve is self cleaning because the liquid enters against the needle point.

4. It has a long range of adjustments; from 35 lb., to 25 in. vacuum.

A cross section of the valve is shown in the accompanying drawing.

Series 40 Belt Conveyor Idlers

SERIES OF CONVEYOR belt troughing and return idlers equipped with Timken roller bearings has been brought out by The C. O. Bartlett & Snow Co., Cleveland. The bearings of each pulley are provided with


RENEWABLE PULLEY SHELL
FLUSH CLOSED PULLEY END
GREASE CHAMBER AROUND SHAFT
NUT PERMITS BEARING ADJUSTMENT WITH PULLEY IN PLACE
ONLY ¼" GAP
METAL QUADRUPLE LABYRINTH SEALS
OUTSIDE SUPPORTING BRACKET
EXTENDED LUBRICATION LEAD FOR INNER BEARINGS

CONSTRUCTION DETAILS OF SERIES 40 IDLER

a positive screw adjustment so arranged that wear may be taken up without removing the pulley from the supporting brackets.

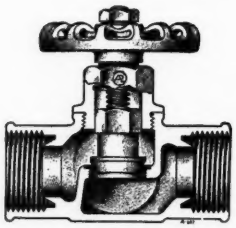
Provision is made for renewing the pulley shells without destroying the pulley ends, which are made of cast iron. These renewable shells are made from seamless steel tubing, ¼ in. thick and 6 in. in diameter. Use of uniform tubing results in a well balanced pulley, it is stated, designed to reduce belt wear by virtually eliminating slippage over the pulley.

Four brackets, mounted on an inverted steel channel support the three pulleys of the troughing idler which provide a continuous support across the belt except for a ¼-in. gap between pulleys. Open tops in the brackets are to permit any pulley to be removed without disturbing the bracket or adjacent pulley. The single pulley of the return idler is similar to the pulleys of the troughing idler; its brackets, however, are of the hanging type.

A single grease fitting serves to lubricate the two bearings of each pulley in the troughing idlers. The longer return idler pulley has a fitting for lubrication at each end. A central tube is used to prevent the escape of grease into the pulley interior. As the flow of grease is toward the outside, the bearings are flushed as they are greased.

Valves for Small Tubing

GLOBE VALVES designed for connection to copper or steel tube with Parker Tube Couplings are shown in cross section by the accompanying illustration. These units are manufactured by the Parker Appliance Co., Cleveland, O., in connection with their line of tube couplings and Parker tube coupling standards are machined directly into the valve so that no special fitting is needed for connecting the tube. The valve is of the non-rising stem type, with monel or stainless steel trim. An outstanding characteristic is the elimination



GLOBE VALVE DESIGNED BY THE PARKER APPLIANCE CO. FOR COPPER OR STEEL TUBING

of the conventional stuffing-box and as the stem is non-rising, hard washers of correct composition provide a tight stem outlet with the maintenance of a free turning stem. These valves are quoted in standard weight, extra heavy or double extra heavy bronze, for working steam pressures up to 350 lb., or for higher pressures when used in instrument lines where full boiler temperature is encountered but occasionally as when the meter lines are blown down.

Radial Continuous Steel Flooring

EVER SINCE the advent of open steel flooring, or reticuline grating in the industrial and engineering world, one of the most troublesome and costly problems has been to adapt it to circular galleries, walkways,

CONTINUOUS RADIAL STEEL FLOORING OF THE IRVING IRON WKS. CO.

runways and the like. In such cases, it has been necessary to cut the pie-shaped sections from rectangular fabricated panels, to fit them together in the shop, and to band them as separate units. This was costly work, involving not only a waste of fabricated material but of labor as well. The assembled job was only a collection of individual panels and the evenness of the surface as a whole was dependent solely upon the care exercised in mounting and anchoring the panels.

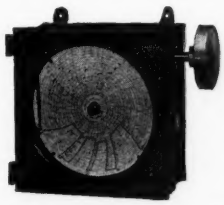
To overcome all these former difficulties, the Irving Iron Works Co. of Long Island, N. Y., has designed Irving Radial Steel Flooring which is fabricated in sections exactly conforming with the customer's drawings, without cutting or banding or any waste of material or labor. These sections are assembled on the

job without fitting, in a continuous, one-piece floor devoid of panel joints. The radiating lines of Irving Radial produce a job much superior to the old patchwork panel construction. The continuous feature also assures a safety surface free from protruding panel edges or bars and obviates all possibility of loose, wobbly panels. The mesh employed is of the familiar Irving pattern in which a double-S crimp given to the reticuline bars provides complete bridging of the openings and a nonslipping surface safe under all conditions.

Operation Recorder

BY MEANS of the new recorder illustrated herewith, speed or rate of production, starts, stops and slowdowns can be recorded on an 8-in. round chart which can be graduated for any unit of output desired.

From a centrifugal movement, connection is made by links to the pen arm, the record being made correctly,



AMTHOR OPERATION RECORDER

with rotation in either direction. The pen has a nonspillable glass reservoir and chart is driven by a standard clock movement for 12 or 24-hr. record. Vibration and shock are eliminated by a damping device. Ball bearings reduce lubrication to a minimum. Drive is from either side or the back by belt, coupling or flexible shaft.

Record is made of any irregularities in operation due to drive of machines, operator's action or faults in material. The recorder, made by Amthor Testing Instrument Co., Brooklyn, N. Y., is applicable to industrial machines, or power plant equipment.

GENERAL ELECTRIC Co. has announced another new, small, mechanical-drive steam turbine, designated Type D-58, for driving fans, pumps and similar industrial equipment. The new turbine is designed for operation at steam pressures up to 250 lb. and speeds between 1200 and 4000 r.p.m., with capacities up to approximately 250 hp. and is built only as a single-stage machine.

By limiting the range of conditions under which this turbine will be expected to operate, it has been possible to decrease the length and width, making it a compact unit with a considerable saving in weight. The turbine is supported at the center line to permit expansion without affecting the shaft alinement. It is equipped with speed regulating and emergency governors and is fitted with carbon shaft packing. The pipe connections are made to the lower half of the turbine to facilitate opening for inspection.

HAVE REPAIRED immediately any leaking steam, gas, oil or water pipes, particularly those near your electrical equipment. Electric wiring should be protected against contact with water or oil.

Westinghouse Vice President Dies

DR. HARRY PHILLIPS Davis, vice president and director of the Westinghouse Electric and Manufacturing Co. and Chairman of the National Broadcasting Co., died at his home, 4917 Wallingford St., Pittsburgh, Pa., on September 10 at 4:15 a. m. He had been ill for several months following an operation.

A man of energy, initiative and vision, his career was one of wide achievement and during his life nearly 80 patents were issued to him for his developments in electrical apparatus. Under his engineering leadership, many advances of the electrical art were made, these

HARRY PHILLIPS DAVIS

relating to meters, measuring instruments, circuit breakers, railway control apparatus, transmission equipments and radio.

For more than 21 of the 40 yr. during which he was connected with the Westinghouse Co., Dr. Davis was in charge of his company's engineering department and for 15 yr. directed its engineering and manufacturing operations. Among his early achievements was his work in the electrification of the New York, New Haven and Hartford railroad, the world's first single-phase railway electrification. He was an important factor in all phases of this electrification as well as others that followed.

As widely known as he was in engineering and industrial fields for his achievements, it is for his development of radio broadcasting that he is most generally known. His initiative in this direction resulted in the development of the first commercial broadcasting station, KDKA.

Born in Somersworth, New Hampshire, in 1868, Dr. Davis was graduated from the Worcester Polytechnic Institute with the degree of bachelor of science in engineering. After a tour of Europe, he joined the Detail Engineering Department of the Westinghouse Co. in 1891. Five years later, he was given charge of this department and in 1904 was made manager of the company's engineering department. In 1911 he was elected a vice president.

Dr. Davis was connected with a number of corporations as a director, among these being the Westinghouse Electric International Co., Automatic Gear Shift Co., Radio Corporation of America, R. C. A. Photophone, Inc., Radio Keith-Orpheum Corporation, and the R. C. A.-Victor Co., Inc., and he held memberships in many

engineering and scientific societies. Locally, he was a member of the University Club, the Pittsburgh Athletic Association and the Oakmont and Edgewood Country Clubs.

His widow, formerly Agnes L. Taylor of Worcester, Mass., one daughter, Mrs. Louis Rockwell, and one son, Harry Ransom Davis survive.

News Notes

NATIONAL ASSOCIATION of Practical Refrigerating Engineers will hold its 22nd annual convention and exhibit of refrigerating machinery at Houston, Texas, Nov. 10 to 13. All refrigerating engineers are invited to attend. All sessions and the exhibit will be in the Houston Municipal Auditorium, one block from the Rice Hotel, which will be headquarters. Reduced railroad rates and winter tourist fares will be in effect. William C. Reinhard of Houston, president of the N. A. P. R. E. is perfecting arrangements for meetings and entertainment.

READING-PRATT & CADY CO., INC., Bridgeport, Conn., announces with deep sorrow the death of its General manager of sales, Wallace McCausland, on Friday, September 4, 1931.

EFFECTIVE September 1, 1931, the sales organizations of Keasbey & Mattison Co. and the Ambler Asbestos Shingle & Sheathing Co. were combined, all sales now being handled by Keasbey & Mattison Co. Factories and main offices of these companies are located at Ambler, Pa. The following officers have been elected for Keasbey & Mattison Co.: Dr. Richard V. Mattison, Chairman of the Board of Directors; A. S. Blagden, President and General Manager; W. J. Donahue, Vice President; Royal Mattison, Vice President; U. G. Funk, Treasurer; Joe Walker, Secretary and Assistant Treasurer; George F. Stone, Sales Manager; Ralph E. Frey, Manager, Building Material Sales; John L. Shoemaker, Manager, Magnesia Sales; Wm. Jacobsen, Manager, Fibre Sales; Harry W. Tuman, Manager, Textile Sales.

DURING THE PAST FEW WEEKS, several important additions have been made to the staff of the Worthington Pump and Machinery Corp., 2 Park Ave., New York, N. Y. At the same time, certain organization changes also were announced. Otto Nonnenbruch, for the past four years chief engineer of the Diesel department of I. P. Morris and De La Vergne, Inc., Philadelphia, Pa., and prior to that with Worthington in various capacities for nine years, rejoined the latter organization as of July 1. Mr. Nonnenbruch will make his headquarters at Buffalo, N. Y., as special sales representative. J. B. Allen, formerly president of the Allen Engineering Co., Bridgeport, Conn., and prior to that time with the Sperry Gyroscope Co., Brooklyn, N. Y., has been appointed special marine representative with headquarters at Harrison, N. J. H. G. Wood, formerly assistant manager of the New England division of the Westinghouse Engineering and Manufacturing Co., has joined the Worthington organization in the capacity of electrical sales engineer. E. M. Paullin, Jr., has been appointed electrical sales engineer at the Cincinnati, Ohio, Works of the Worthington Corporation. Mr. Paullin was associated with the New York office of the General Electric Co. as synchronous motor specialist. John T. Clancy, assistant manager, Buffalo Works sales division, has transferred his headquarters from Buffalo to Harrison, N. J. E. W. Hammond, formerly located at Buffalo, has been transferred to Los Angeles as special representative of Diesel and gas engine sales on the Pacific Coast. A. M. Boehm goes to Kansas City as Diesel and gas engine specialist. He formerly was in the sales department at Buffalo Works. Joseph F. Hecking, formerly with the Diesel engine sales division in New York, has been assigned to the Diesel and gas engine sales division at Buffalo. William J. Daly, assistant manager, Cincinnati Works sales division, has been assigned to Pittsburgh, Pa., on special sales work. G. A. Herrmann, formerly sales engineer at Chicago, has been appointed acting district manager at St. Paul. W. R. Kennedy, sales engineer at Pittsburgh, has been appointed acting district manager at Kansas City.

L. MUNDET & SON, INC., of Texas, announces that its office at Houston, Texas, has changed its location from its former address at 2420 Nance St. to its new building at Commerce and Palmer Streets, Houston. In addition to a complete stock of Mundet products, this office also carries the full line of products manufactured by Keasbey & Mattison of Ambler, Pa.

ANNOUNCEMENT is made by the International-Stacey Corp., Columbus, Ohio, that B. T. Ehrnman formerly in the Chicago office of the corporation has been transferred to St. Louis as division manager with offices at Room 2192, Railway Exchange Building. Mr. Ehrnman has been associated for a number of years with the Roots-Connersville-Wilbraham Division of the company.

AT THE LAST MEETING of the Board of Directors of the Johns-Manville Sales Corp., T. K. Mial, R. C. Harden, G. R. Lewis, J. M. Taylor and Franklin Shuey were elected vice-presidents, to have executive supervision of various territorial districts. The districts for which these executives will be responsible are as follows: T. K. Mial, Metropolitan Boston, Philadelphia and New York State; R. C. Harden, Chicago, St. Louis, Northwestern and Denver; G. R. Lewis, Cleveland, Detroit, Pittsburgh and Cincinnati; J. M. Taylor, New Orleans, Atlanta and Houston; Franklin Shuey, San Francisco, Los Angeles and Seattle.

LUDLOW VALVE MFG. CO., of Troy, New York, will manufacture in Canada as The Canadian Ludlow Valve Mfg. Co., Ltd. Offices are located at 930 Wellington St., Montreal, Que., and factories at Three Rivers, Que., St. Thomas, Ont., and Fort William, Ont.

HIMELBLAU, AGAZIM & CO., 30 N. Dearborn St., Chicago, announces that it has recently taken over the Chicago office of the Ames Pump Co., Inc., of Dunkirk, N. Y., affiliated with the American Locomotive Co., of New York, and is to handle the Ames products in northern Illinois and northern Indiana.

MORGAN SALES & SERVICE CO., Knoxville, Tenn., has recently been appointed sales agent in East Tennessee for the Dayton-Dowd Co., W. H. Nicholson & Co. and E. B. Badger & Sons Co.

NORTHERN BLOWER CO., West 65th St., South of Denison, Cleveland, Ohio, announces that C. W. Traughber has been appointed technical and metallurgical adviser of the organization. Mr. Traughber comes to the Northern Blower Co. after an association with Anaconda Copper Co., American Smelting & Refining Co. and other large smelting plants, for many years.

ANNOUNCEMENT has been made that the Frick Co., Waynesboro, Pa., has taken over the Knickerbocker Stamping Co., whose manufacturing plant is at Parkersburg, W. Va. The Knickerbocker Stamping Co. was owned by the American Ice Co., and through the purchase it becomes a wholly owned subsidiary of Frick Co. with a new body of directors. The officers and directors are: president, D. Norris Benedict; vice pesident and manager, George A. Stevenson; vice president, William H. Aubrey; secretary-treasurer, M. E. Gordon; directors, Ezra Frick and D. B. Snively. The company will be operated as a separate factory at Parkersburg with its own board of directors, factory and sales organization.

Books and Catalogs

UNDERGROUND SYSTEMS REFERENCE BOOK. First Edition; by an editorial staff of the Underground Systems Committee of the N. E. L. A.; size, 9 by 12 in.; cloth, 377 pages, illustrated. Published by the National Electric Light Association, New York, N. Y., 1931; price $4.00

A comprehensive volume devoted to a description of accepted practice in the design, construction and operation of underground systems of electric distribution. Edited by a staff of engineers under the direction of the Underground Systems Committee of the National Electric Light Association, this is an authoritative work on modern underground system practice as is available anywhere. For a number of years the Underground Systems Committee had contemplated the publication of a book of this character and after a thorough canvass of the industry in order to determine the demand for a reference book, the editorial staff was appointed.

It has been the purpose of the editors to present the material and information in a manner truly representative of the accepted practice in the industry. In order to eliminate the personal element as much as possible two plans were adopted, first the choosing of a relatively large staff of associate editors for each chapter and second, having the several chapters critically reviewed by individuals not directly connected with the compilation of the original manuscript.

In the compilation of this book, all tables, statistics and other general data found in standard reference books now available were omitted. The book has been prepared for the man in the field as well as for the man in the office.

Cables and their insulation, conduit and manhole design and construction, cable installation, splices and terminals, cable operation, miscellaneous equipment and safety practices are discussed in detail. A bibliography of over 4,000 references is appended to the report. The book is well illustrated and has an excellent index.

ALUMINUM PAINT AND its uses are discussed in an attractive booklet issued by Aluminum Co. of America, Pittsburgh, Pa. It tells the best methods for using and shows application for reduction of corrosion, lessening of heat radiation and improvement of appearance on structures, equipment and manufactured products. Priming of wood surfaces to prevent absorption of moisture is a recent development.

PRINCIPLES OF ENGINEERING ECONOMY, by Eugene L. Grant. Published by the Roland Press Co., 15 E. 26th St., New York, N. Y.; 6 by 9 in., cloth, 380 pages; price, $3.75.

By no means the least important part of an engineer's work is the selection of equipment from an economic standpoint, often referred to as dollar engineering. In spite of this, there is a dearth of understandable literature on the subject. In this book, the principles of cost comparison are illustrated by particular cases rather than in terms of mathematical formulas; actually most problems in economy are solved as problems in arithmetic and a mathematical treatment obscures the fundamentally simple arithmetical relationships and fails to give proper weight to nonquantitative judgment factors.

The first part of the book deals with a direct comparison of cases, interest, depreciation, load factor and obsolescence. Part II deals with fact finding for economy studies and Part III with the background for these studies. Part I has direct and practical application for those engineers who must help select equipment while the balance of the book is valuable for those interested in pursuing the subject farther into the realm of accounting and statistics for the purpose of obtaining data for complete studies. Selected references at the ends of chapters add to the value of the book.

MODERN COMBUSTION, Coal Economics and Fuel Fallacies; by Clarence V. Beck, published by Mid-West Coal Retailer, 20 West Jackson Blvd., Chicago, 1931; price, $3.00.

Those interested in the use of coal as fuel will find in this book an elementary treatment of the problem which was evidently intended to put the reader in possession of information which will bring the use of coal up to modern conditions of combustion efficiency. The author is president of the St. Louis Coal Co. and an executive of Lumaghi Coal Co., and presents the subject from that viewpoint rather than the viewpoint of the engineer using coal. The book is divided into three parts, Part I dealing with coal economics, Part II with fuel fallacies and Part III with combustion.

ECONOMIC CONTROL of Engineering and Manufacturing; by Frank L. Eidmann, McGraw-Hill Book Co., Inc., New York, 1931; price, $4.00.

The subject matter of this most interesting book has been used by the author as the basis of a course in the school of engineering at Princeton University. The material has been gathered from many sources and incorporates much material from the author's experience in engineering and manufacturing organizations. Throughout the entire book the economic problems of the industrial engineer have been stressed and the author illustrates with many examples the solutions to many economic problems met by the industrial engineer. To the power plant engineer, four chapters out of the 21 included in the book should be of special interest. These are: Chapter II, dealing with financial calculations; Chapter IX, dealing with economic considerations in the selection and purchase of equipment, taking up such problems as the principles that govern the selection of equipment, economic considerations in selecting equipment, graphs as an aid in the selection of equipment, how soon should new equipment pay for itself, buying used machines, the selection of nonproductive equipment and the importance of safety features; Chapter XI takes up a consideration of the economics of equipment replacement under such sub-headings as—when equipment should be replaced, economics or replacement, the disposition of obsolete equipment, interest on savings should be considered and a replacement experience. Chapter XIX is devoted to Economics of the Power Plant, dealing with methods by which to determine whether power should be generated or bought, the savings produced by power plant accessories, commercial efficiency, and furnace efficiency.

In the solution of these problems, the author resorts to simple algebraic equations, curves and diagrams which are easily understood, making the entire book one of considerable value to the industrial engineer having to do with economic problems.

PUBLICATION dealing with Power and Fuels issued in Japan are listed and summarized in a bulletin issued monthly by the Japan Power Assn., Yuraku Building, Marunouchi, Tokyo. These are part of a plan of the World Power Conference for bulletins from each country to give monthly the bibliography of important contributions to power plant data. Some of the titles given in the June Bulletin from Japan are: Lubrication by Mineral Oil Mixed with Rape Oil; Soyama Hydro-electric Power Plant; Turbine Generator in Paper Mills; Rupturing Test of Oil Circuit Breakers; Voltage Rise in Mercury Arc Rectifier; Strength of Flexible Steel Poles.

CELORON GEARS, designed to be silent, waterproof, long-wearing, manufactured from impregnated sheets of woven fabric subjected to pressure and heat in hydraulic presses, are described in detail with many illustrations of their applications in a new bulletin issued by Continental-Diamond Fibre Co., of Newark, Delaware.

ENGELHARD PORTABLE GASALYSER employing the principle of thermal conductivity for the continuous analysis of industrial gases is completely described in a new bulletin issued by Charles Engelhard, Inc., Chestnut St. and N. J. R. R. Ave., Newark, N. J. The bulletin describes the instrument in detail, discusses its principles of operation and shows how it can be used to measure a number of different gases without any change in the instrument.

TRICHLORETHYLENE, its properties and uses as a solvent of oils, fats, gums, tars and many resins and as a cleaning agent for degreasing fabrics and metal surfaces are fully described in a pamphlet issued by the Roessler & Hasslacher Chemical Co., 350 Fifth Ave., New York, N. Y.

SOLENOID VALVES for automatic and remote control of air, gas, steam and liquids are described in a 12-page, letter-size bulletin just issued by Automatic Switch Co., 154 Grand St., New York City.

PHOTOGRAPHS, tables, engineering data and formulas relating to all types of gears are given in a new 100-page catalog, No. 100, just issued by the Earle Gear & Machine Co., 4707 Stenton Ave., Philadelphia, Pa.

HIGH TEMPERATURE MORTARS and plastic chrome ore for every need are described in a recent 16-page, well-illustrated booklet issued by the General Refractories Co., 106 South 16th St., Philadelphia, Pa.

BARE ELECTRIC IMMERSION HEATERS for asphalts, tars, compounds, oils, varnishes and similar viscous materials are described in detail in bulletin No. 230, superseding bulletin No. 170, issued by H. O. Swoboda, Inc., 3400 Forbes St., Pittsburgh, Pa.

FAIRFIELD SKIP HOISTS, their design and construction features and several views of typical installations, are contained in bulletin No. 60-1 just issued by the Fairfield Engineering Co., Marion, Ohio.

THE THOROUGHBRED IS MORE THAN A HORSE—HE IS MANY HORSES, is the title of a recent bulletin issued by the Foxboro Co., Foxboro, Mass., describing in detail various features of Foxboro recording thermometers.

CONVERTIBLE HEAT EXCHANGERS, double tube type, convertible open type cooler and convertible heat exchangers, standard type, are described in new bulletins just issued by Thermal Engineering Co., 701 Spring Arcade Bldg., Los Angeles, Calif.

CENTRIFIX PURE STEAM RECORD, bulletin 161, giving results obtained with the Centrifix purifier in a number of industrial plants, has recently been issued by the Centrifix Corp., 3029 Prospect Ave., Cleveland, Ohio.

SWENDEMAN automatic separator for use on compressed air lines is described and illustrated in detail in a recent bulletin issued by the Leavitt Machine Co., Orange, Mass., which has purchased the separator business from the Swendeman Corp., Boston, Mass.

STANDARD and heavy duty blowers and gas pumps are described in detail in four new bulletins just issued by the Roots-Connersville-Wilbraham division of the International-Stacey Corp., Connersville, Ind. These bulletins supersede all former bulletins on these products issued separately in the past by the various associated companies.

THE LONERGAN LINE of power plant specialties is described in a 92-page illustrated catalog just issued by the J. E. Lonergan Co., Philadelphia, Pa. Specialties described in this catalog include pop safety valves; relief valves; pressure and vacuum gauges for steam, air, water, ammonia etc.; test gauges; water level gauges; gauge cocks; steam gauge syphons; whistles, plain and chime; oil cups, grease cups, multiple oilers, oil gauges and other lubricating specialties.

GENERAL CATALOG, of more than 100 pages, describing the complete line of TAG controllers, recorders, dia's, thermometers, hydrometers, oil testing instruments and moisture meters has just been issued by C. J. Tagliabue Mfg. Co., Brooklyn, N. Y. Appropriate classifications of the many groups of instruments have been carefully considered and many applications of these instruments, are described. Several pages are devoted to a pictorial story of their manufacturing processes. In addition, there is information of interest to the chemist, laboratory worker, plant superintendent and executive.

Power Plant Construction News

Ala., Silver Hill—The Riveria Utilities Co., Foley, Ala., is considering the construction of a transmission line from Robertsdale to Silver Hill and vicinity, with power substation facilities. The company is concluding arrangements for the purchase of the Silver Hill Power Co., and will consolidate with its organization.

Calif., Bay Point—Congoleum-Nairn, Inc., 195 Belgrove Drive, Kearney, N. J., plans installation of electric power equipment, as well as boiler house and other power facilities, in connection with new linoleum and floor covering manufacturing plant at Bay Point, Contra Costa County, Calif., entire project to cost over $1,000,000. Sanderson & Porter, 1 Montgomery Street, San Francisco, Calif., and 52 William Street, New York, are engineers.

Calif., Los Angeles—The Stauffer Chemical Co., Rives-Strong Building, plans installation of electric power equipment in proposed new factory in Dominguez district, entire project to cost about $60,000.

Calif., Redwood City—The Union Ice Co., 354 Pine Street, San Francisco, Calif., has approved plans for a one-story ice-manufacturing plant on Brewster Avenue, Redwood City, 100 x 126 ft., to cost over $45,000, with machinery. Company engineering department, address noted, is in charge.

D. C., Washington—The Bureau of Supplies and Accounts, Navy Department, Washington, will receive bids until Sept. 15, for a quantity of rubber pump valves for eastern and western yards, as per Schedule 6432. Also, at the same time, for 100 hand fuel pumps for the Philadelphia yard, as per Schedule 6430.

Fla., West Palm Beach—The Florida Utilities Co., West Palm Beach, is planning extensions and improvements in plant and system, including installation of additional equipment.

Ga., Atlanta—The Dixie Terminal Co., Atlanta National Bank Building, Atlanta, is said to be arranging for the early construction of its proposed new dry and cold storage plant on local site, to be nine-story, estimated to cost close to $1,000,000. Cold storage and refrigerating equipment, as well as power equipment will be installed. A. Epstein, 2001 West Pershing Road, Chicago, Ill., is engineer, in charge.

Ga., Lindale—The Pepperell Mfg. Co., Biddeford, Me., plans installation of electric power equipment in connection with a new cotton mill unit at Lindale, entire project to cost over $300,000.

Ind., Huntingburg—The City Council, Huntingburg, has asked bids on general contract for an addition to municipal electric light and power plant, estimated to cost about $40,000, with equipment, including boiler, stoker and accessories. Charles Brossman, Chamber of Commerce Building, Indianapolis, Ind., is consulting engineer.

Ind., Richmond—The Board of School Trustees, Richmond, W. G. Bates, superintendent of schools, is planning installation of new equipment in boiler plant at the Morton high school, including boiler units, stokers, etc. Hamilton, Fellows & Nedved, Tower Court, Chicago, Ill., are architects.

La., Metairie—The East Jefferson Water Works District No. 1, Matairie, is said to be planning installation of pumping machinery and auxiliary equipment in connection with extensions and improvements in water system, entire project to cost about $300,000.

Mass., Chester—The Chester Granite & Polishing Co., Chester, is said to be planning installation of electric power equipment in connection with proposed rebuilding of portion of plant, recently destroyed by fire with loss reported over $80,000.

Mich., Ecorse (Detroit)—The Murray Corporation of America, Escorse, plans installation of electric power equipment in two new additions to metal stamping plant for automobile bodies and other service, entire project to cost over $100,000.

Minn., Edina—Ben B. Moore, Village Recorder, Edina, (address 4605 Wooddale Avenue, Minneapolis, Minn.) is asking bids until Sept. 15, for two motor-driven pumping units for municipal sewage system, as per specifications on file. Albert Graber, Phoenix Building, Minneapolis, is engineer.

Minn., Kenyon—The Village Council, Kenyon, contemplates a municipal electric power substation and distributing plant to cost about $45,000, with equipment. A municipal electric generating station is also under advisement, estimated to cost $70,000. A. S. Kindseth is village clerk.

Minn., Two Harbors—The Common Council, Two Harbors, is said to be planning an early call for bids for a municipal gas plant and system. Ernest Carlson is city clerk.

Mo., Lebanon—The Missouri Electric Co., Dubuque, Iowa, has made application for permission to build a power dam on the Niangua River, near Lebanon, Mo., for hydroelectric power service, estimated to cost over $650,000. Company engineering department will be in charge.

Mo., Windsor—The International Shoe Co., 1505 Washington Street, St. Louis, Mo., plans installation of electric power equipment in proposed new factory at Windsor, entire project reported to cost over $90,000.

Mont., Deer Lodge—The City Council, Deer Lodge, is said to be planning installation of pumping machinery and other power equipment in connection with a proposed municipal water system, entire project to cost close to $200,000.

N. C., Asheboro—The Cetwick Silk Mills, Inc., Asheboro, plan installation of electric power equipment in a new three-story addition to cost close to $100,000. R. C. Biberstein, Charlotte, N. C., is architect. E. L. Cetwick is president.

N. C., Charlotte—The Hudson Silk Hosiery Co., North Brevard Street, plans installation of electric power equipment in proposed new addition to mill, entire project to cost close to $100,000. It is expected to begin work early next year. F. Seifart is president and treasurer.

N. C., Valdese—The City Council,, Valdese, is said to be planning installation of pumping machinery and auxiliary power equipment in connection with extensions and improvements in water and sewage systems, for which a bond issue of $155,000 has been approved. J. B. McCrary & Co., Atlanta, Ga., are consulting engineers.

Ohio, Ashtabula—The Lake Shore Gas Company, Ashtabula, is said to be planning installation of a compressor station in connection with a new pipe line for gas service to Conneaut, Ohio, and vicinity, entire project to cost about $200,000. F. W. Stone is manager.

Ohio, Girard—The Pennsylvania Railroad Co., Broad Street Station, Philadelphia, Pa., plans installation of electric power equipment in proposed new engine house and terminal, including shops, etc., at Girard, entire project reported to cost over $600,000. Company engineering department will be in charge.

Ohio, Lima—The City Council, Fred C. Becker, City Hall, city manager, is considering the construction of a municipal electric power station for service at the city waterworks, sewerage disposal plant and city institutional buildings. Estimates of cost will soon be made.

Ohio, Youngstown—The Dunning-Crum Coal & Ice Co., Youngstown, is planning extensions in ice-manufacturing plant, with installation of additional machinery for increased output.

Okla, Pryor—The City Council, Pryor, is considering the installation of a purification plant for municipal water service, in conjunction with a power station, entire project to cost about $100,000. V. V. Long & Co., Colcord Building, Oklahoma City, Okla., are consulting engineers.

Ore., Portland—The Portland Battery Mfg. Co., East Seventeenth and Tacoma Streets, plans installation of electric motors and other power equipment in proposed new one-story plant, 100x500 ft., entire project to cost in excess of $100,000. J. W. DeYoung, 350 Salmon Street, is architect.

Pa., Philadelphia—The Consolidated Cigar Corporation, 619 Moore Street, plans installation of electric motors and other power equipment in new seven-story factory at Eleventh and Wharton Streets, entire project to cost over $300,000. Julian S. Simsohn, 933 North Broad Street, is architect and engineer.

Que., Montreal—The Board of Public Works, City Hall, is said to be planning construction of a pumping plant at the foot of Atwater Avenue, with installation of electric-operated pumping units and accessories, reported to cost over $75,000.

Texas, Bogata—The Common Council, Bogata, is reported planning the installation of a municipal electric light and power plant. Estimates of cost will soon be made.

Wash., Seattle—The National Steel Construction Co., Seattle, contemplates installation of electric power equipment in connection with proposed rebuilding of portion of iron and steel plant, recently destroyed by fire with loss of over $75,000.